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Erecting the Kill van Kull Bridge

BY HENRY W. TROELSCH

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THE Kill van Kull Bridge, now under construction in New York Harbor, is of especial interest not only because it contains the longest arch span ever built, but because of the method by which it was erected. The bridge crosses the Kill van Kull from Bayonne, N. J. to Port Richmond, Staten Island, N. Y., and forms part of the improvements in transportation facilities undertaken by the Port of New York Authority, an interstate commission charged with the development of the port.

After making comparative studies of a cantilever bridge, a suspension bridge, and an arch, the engineers selected a two hinged arch as best meeting the requirements of cost, rigidity under traffic, and appearance. The arch is 1675 feet long, center to center of bearings on the masonry, and 1652 feet 1 inch center to center of end pins.

The bridge crosses the river at a considerable skew, necessitating a somewhat longer span than a square crossing; but the additional expense involved was compensated by the smaller cost of land for the approaches and the better connection to existing streets.

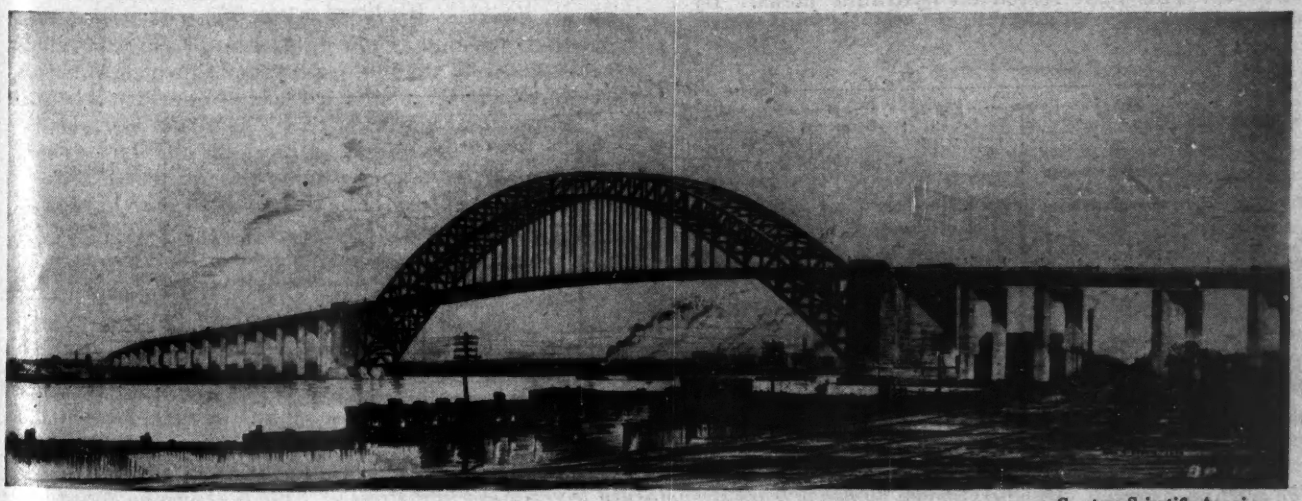
Two Trusses In Arch

The arch has two trusses with parabolic chords, divided into 40 panels. The lower chord has a rise of 266 feet, and the trusses are 67 feet 6 inches deep at the ends and 37 feet 6 inches deep at the center. The trusses are 74 feet apart, and are braced by top and bottom bracing of the "K" type.

In the central part of the arch the floor is suspended on wire rope hangers. As it approaches the ends of the span the floor passes between the trusses, and for two panels at each end it is carried on columns above the trusses.

The bridge as now being built will carry a 40-foot roadway and a six-foot sidewalk. In the future the roadway can be widened to 65 feet, or two rapid-transit railway tracks can be added outside the 40-foot roadway.

Three grades of structural steel are used in the arch span. For the lower chords, manganese steel, with a yield point of 55,000 pounds per square inch, is used. The upper chords, the main floor beams, and some of the smaller beams in the floor, are made of silicon steel having a yield point of 45,000 pounds per square inch. For the web members of the trusses, the shoes, bracing, stringers, and minor parts, the design called for carbon steel with a yield point of 35,000 pounds per square inch. Rivets are of carbon steel, except for the field connections of the trusses, where manganese steel was used, with a working stress 50 per cent in excess of that allowed on carbon steel rivets.



Courtesy, Scientific American

Artist's drawing of the completed span.

Arch Arms Meet Off Center

The method of erection was determined largely by the location of the ship channel, which lies near the south shore. The channel had to be kept open at all times. Consequently no falsework or other obstructions could be placed in the river for a space of 17 panels, or 702 feet, extending from Panel Point 7 on the south side to Panel Point 16 on the north side. The arch was erected in two parts, one arm extending out from each side of the river until the two arms met over the channel at Point 14 south, 248 feet south of the center of the span.

The south arm complete. Only the larger bent is carrying load.

The south arm was erected first, with the shore end resting on the abutment and the outer part supported successively on bents at Panel Points 1, 2, 4, and 7. A traveling derrick or "traveler," designed to move along the upper chord, was assembled on a temporary tower over the abutment. This traveler then erected the shoes and the first panel of steelwork, supporting the outer end on Bent S1. Moving out on the first panel, the traveler then erected the second panel as a cantilever, bringing the end of the steelwork over Bent S2. This bent rested on hydraulic jacks. By raising these jacks the structure was lifted until it was clear of Bent S1 and all the load was carried on Bent S2.

Erection then proceeded by cantilevering two more panels, bringing the steelwork over Bent S4, to which the load was transferred by lowering Bent S2. Cantilevering three panels further brought the steelwork over Bent S7, which was provided with jacks at the top. These jacks lifted the structure clear of Bent 4. With the structure supported only at the shoe and Bent S7, seven additional panels were added by the traveler as it moved out, forming a cantilever which extended 289 feet beyond the bent. The traveler was then backed off and taken across the river for the erection of the north arm.

Erection By Cantilevering

On the north arm falsework bents were placed at Panel Points 1, 2, 4, 7, 11, and 16, with jacks at Points 2, 7, and 16. Erection proceeded by cantilevering and transferring the load from bent to bent as for the south arm. Bent N11, however, was not fully released when Bent N16 was reached, but continued to carry part of the load until shortly before the arms met. The retention of Bent N11 reduced the bending in the arch between points 0 and 16, and reduced the vertical load on the north abutment. The north arm extended 10 panels, or 413 feet, beyond the outermost support.

Bents S7 and N16 were made so high that when both arms were complete there would still be a clearance of six inches between their ends. To "close" the arch, the jacks at S7 and N16 were lowered simultaneously until the two arms, rotating about the shoe pins, came together on a 16-inch pin in the lower chord at Point 14 south. By lowering the jacks further until the bents were free the span was "swung" as a three-hinged arch, with the inner hinge at Point 14 south. The insertion of the upper chord members

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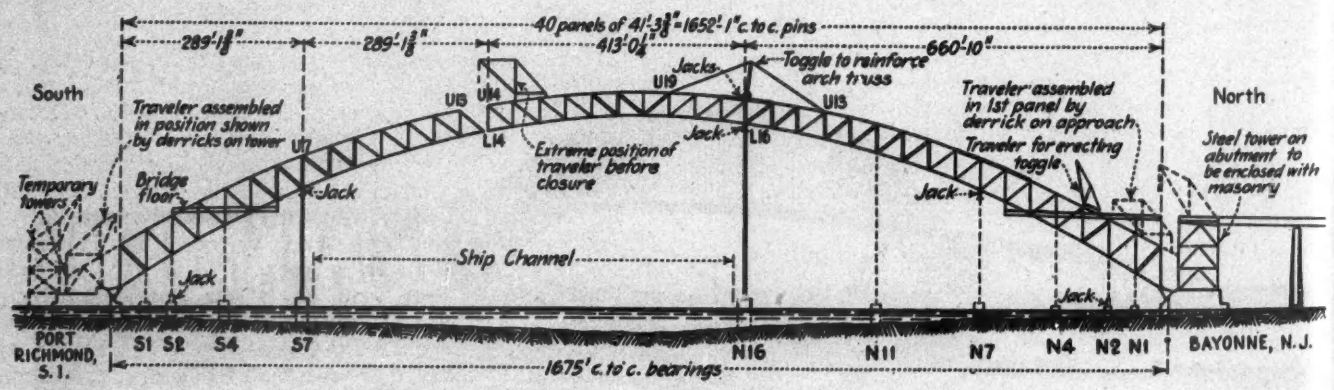
40 panels of 41'-3⅜" = 1652'-1" c. to c. pins
289'-1⅞"
289'-1⅞"
413'-0"
660'-10"
Toggle to reinforce arch truss
Jacks
South
North
Traveler assembled in position shown by derricks on tower
Traveler assembled in 1st panel by derrick on approach
Traveler for erecting toggle
Steel tower on abutment to be enclosed with masonry
Extreme position of traveler before closure
Temporary towers
Bridge floor
Jack
Ship Channel
PORT RICHMOND, S. I.
S1 S2 S4 S7 N16 N11 N7 N4 N2 N1
BAYONNE, N. J.
1675' c. to c. bearings

The erection scheme. Members shown by heavy lines strengthened to resist erection stresses. Bents shown by dotted lines were released before the arch was ready for closure. Note that jacks are used only in alternate bents.

Tile Manufacture

BY HORACE F. CREW

General Superintendent, American Encaustic Tiling Co., Ltd.

THE successful use of floor and wall tile dates from the beginning of world history. Today it truly blends the beauteous creations of the artist and the technique of the trained ceramist with the efficiency and exactness of the chemical, mechanical, and electrical engineers of this period.

The early operator performed his miracles of Ceramic Art entirely by hand, depending upon his trained muscles and experienced vision in determining the finishing points of his various processes. His sources of raw materials were limited to the confines of his particular ability in discovery and identification thereof.

The manufacture of the first ceramic floor and wall tile in the United States, was in the year 1875. Since that time the industry has progressed rapidly and the successful use of the product is truly exemplified in the thousands of beautiful installations of modern floor and wall tile throughout this country and abroad.

Floor, wall, and decorative tiles are used extensively in hotels, hospitals, government buildings, dairies, vehicular tunnels, and municipal subways. The modern home is incomplete without at least one tile bath. They are sanitary and permanent, always lending themselves to beautiful and harmonious treatments blending pleasingly with surrounding conditions. Inasmuch as tiles can be manufactured in many various designs and colors, they are easily adapted to a wide variety of architectural purposes.

Tile Ingredients

In the production of a white tile, which is so common for use in the floors and walls in modern homes and office buildings, great care must be taken in the selection of the various clays and minerals necessary to obtain the properties of exhibiting a white color when burned. While most of the large tile plants are located in Ohio and the East, the clays necessary to produce a white body tile are imported from various parts of the United States and Europe. Inasmuch as no clay has as yet been found which incorporates within itself all of the properties necessary for the proper fabrication of a tile, it is necessary to blend together several clays and mineral products in order to produce a resultant body that will provide for all the necessary properties of the finished product. This blend, once established, becomes the body formula and is the basis upon which the tile body is composed.

The principal ingredients employed in the manufacture of tile, consists of the following:

FLINT—From Ohio, Pennsylvania, and Illinois.

FELDSPAR — From New Hampshire, Maine and Canada.

CORNWALL STONE — From England.

CLAYS (CHINA) — From England, Florida, North Carolina, and Georgia.

CLAYS (BALL) — From Kentucky and Tennessee.

These materials are all received at the plant in a pulverized condition and have been washed by the clay producer. The Flint serves as the refractory body material and is the chief factor in resisting abrasion in the finished product. The Feldspar and Cornwall Stone provide the fluxing agents which melt the Flint and Clay into a compact mass during the firing process. The Clays furnish the plasticity to the raw body, thereby enabling the operators to successfully handle the fragile unfired material as it is pressed into proper shapes.

Ingredient Preparation

Most modern floor and wall tiles are made by the dust-pressed process which requires that the clay body be specially and carefully prepared. To accomplish this, the various materials mentioned above are properly proportioned according to the body formula and enough water added to the mixture to make a slip having about the consistency of thick cream. This mass is agitated in tanks called "Blungers," the agitating mechanism consisting of horizontal paddles revolving on a vertical shaft. The materials must be agitated until complete disintegration has taken place and the various materials have become thoroughly mixed for a homogeneous whole.

Drying

This blunging process requiring about two hours, is followed by subsequent screening and filtering or dewatering. The slip, as it comes from the blungers, is passed through finely woven copper screens to separate any materials which would be too coarse for producing a fine body. The filtration of the slip is accomplished by means of huge filter presses operating under a high pressure. After the filtering operation is completed, the clay slip mixture is reduced to a cake having a structure approximating heavy grease. Further drying is necessary, and this produces a prepared body which, following the next operation, the pulverizing and screening process, contains approximately ten per cent moisture. After the pulverizing operation, the clay body is in the form of a dust which has the proper moisture content so that when squeezed in the hand the clay will form a firm ball. The preparation is now ready for pressing into the desired shapes.

Various Presses Used

This is accomplished by various types of presses — hydraulic, power, friction drive, and combinations of a all. Many of these presses develop a pressure of two thousand pounds or upwards per square inch of surface. The dies are usually of metal and require various ingenious methods of pressure equalization and air release. The body, in the form of the damp dust, is placed in the metal dies and subjected to the pressure of the press. The press imparts to the tile its final shape and contour, but it is still a fragile unit and merely a mechanical mixture of refined mineralogical components. As the tiles come from the press, they are carefully cleaned around their edges so as to remove any excessive clay that may have been pushed on the edges as a result of the pressing operation.

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The Pont du Gard

BY CHARLES M. SPOFFORD

Head of the Department of Civil and Sanitary Engineering, M. I. T.

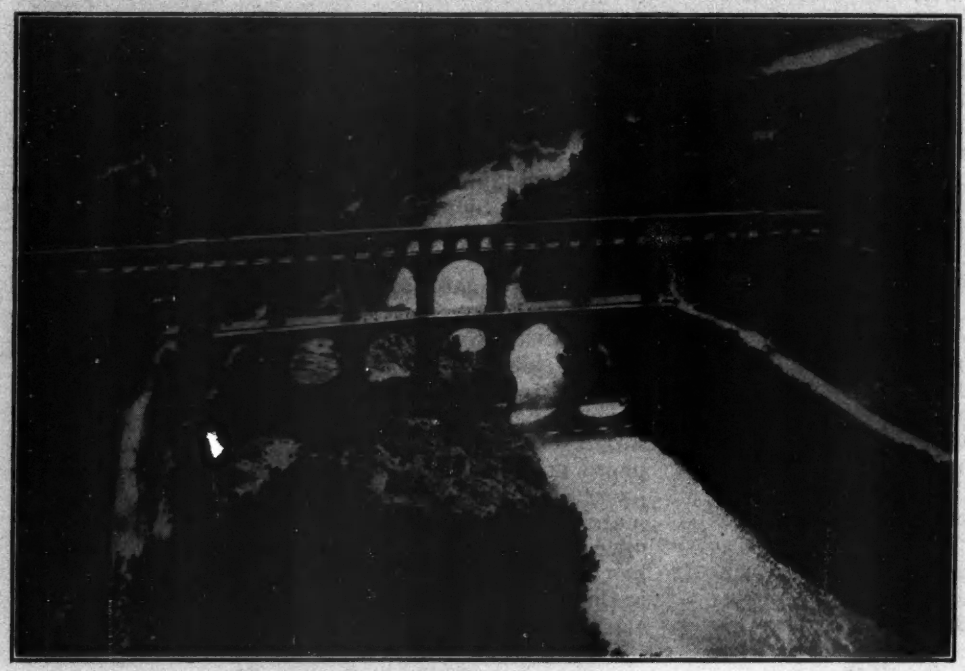
MASONRY arches have been used for over 5000 years, if we can rely upon the date ascribed to the arches excavated in 1927 at Ur of the Chaldees by the Joint Expedition of the University of Pennsylvania and the British Museum. It was the Romans, however, with their great engineering ability, who developed the arch and made extensive use of it in the construction of bridges, aqueducts and buildings. They not only built numerous stone arch bridges across the Tiber in Rome, but also in Southern France and Spain, and some of these bridges are still in use, at least in part. Others have been ruined by floods as the Romans either did not understand the art of constructing foundations or did not wish to go to the expense of constructing suitable permanent foundations for their bridges. With their aqueducts, however, crossing wide valleys, with foundations on dry land or in shallow water, they were more fortunate, and today these aqueducts represent most vividly the wonderful skill of the Roman builders as is well illustrated both by the permanence and the attractiveness of their many constructions.

The Pont du Gard

Most widely known and most attractive in appearance, and the most remarkable example of the boldness and skill of the Roman builders, is the Pont du Gard, now one of the historic monuments of France. This famous structure is a masonry bridge forming a part of a long aqueduct built to carry water to the City of Nimes, France. The bridge crosses the Gardon River at a distance of about 13 miles from Nimes, and about an equal distance from Avignon; it has a total length of 885 feet at the top and a maximum height above the water of 160 feet. In the entire 30 miles of length of the aqueduct, there were several other masonry arch bridges of short span, and several tunnels, the longest having a length of 400 meters.

The aqueduct was probably built about 20 B.C. during the reign of the Emperor Augustus and under the immediate direction of his son-in-law, Agrippa, but has not been used since the Ninth Century, although schemes for utilizing it again were considered by the City of Nimes in 1802 and 1844, and in 1862 by a private company.

The source of supply for the aqueduct consisted of large wells near the City of Uzes. The supply is extremely calcareous and the aqueduct channels were, in time, much reduced in size by deposits from these waters. Between Nimes and the bridge, deposits occur in layers of variable thickness indicating interruptions of the flow of water from time to time. The number of years necessary for each of the different deposits has been computed on the basis of an annual deposit of 0.0015 meters giving results agreeing quite closely



Bird's-eye view of the aqueduct. It is 885 feet long and 160 feet high above the water. The lower series of arches supports a modern roadway erected against the old structure.

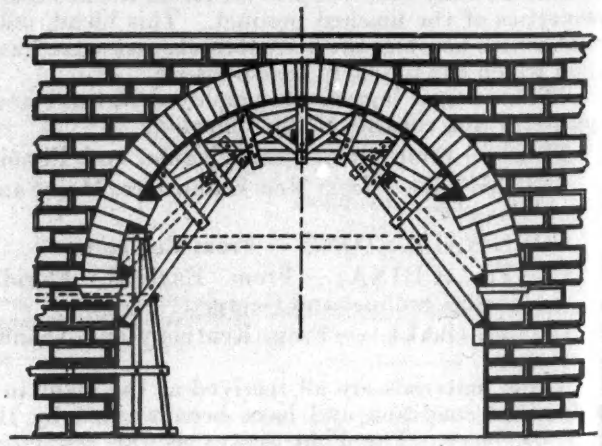


Diagram illustrates possible method of arch centering used by the Romans in erecting the Pont du Gard. The use of small projecting stones to support the falsework is shown.

with the periods of time between various sieges of Nimes, indicating that the aqueduct was cut at the time of these sieges to deprive the city of water. These deposits also indicate that the aqueduct was in use more or less continuously up to the Ninth Century. During this century, however, the Normans devastated the district between Nimes and Arles, and the population of Nimes became so reduced that it probably no longer needed the water and ceased to maintain the aqueduct.

Main Portion of Limestone

The main portion of the Pont du Gard is built of cut limestone taken from a quarry situated about 600 meters from the site. Like other Roman structures, the arch rings are, for the greater part, semi-circular, the segmental arch not being used to any extent by the Romans. The stones of the arch rings were laid in the dry, which required their abutting surfaces to be cut and dressed with extreme accuracy. The lower row of arches is made up of four arch rings side by side and not bonded together. The row above is made up of three rings side by side and unbonded. Mortar was used only in the upper portion carrying the aqueduct channel. Projecting stones were laid in various places doubtless to facilitate the support of the arch centering, as indicated by the accompanying sketch showing a possible method of centering. Some of the stones bear antique inscriptions which are apparently erection marks showing the position of the stone in the arch rib.

It is interesting to speculate on how these early builders raised the large and heavy stones used in the structure. That the Romans were familiar with the use of blocks and tackle is indicated by a bas-relief from the tomb of Haterii, in the Lateran Palace in Rome. This bas-relief suggests at the left of the picture a device which might have been employed for such purposes. It consists of a mast or gin pole with rigging at the top and a cylinder at the bottom, which latter could apparently be rotated by men entering the compartment, giving somewhat the effect of a vertical treadmill.

Both Aqueduct and Bridge

While the Pond du Gard was built primarily as an aqueduct, it made a convenient passageway across the valley and was presumably used as a bridge from the time of its construction by pedestrians who could cross upon the slabs covering the channel at the top of the structure or upon the projecting courses at the top of each of the two tiers of main arches. The fact that the river was sometimes subjected to severe floods preventing a passageway even by boats naturally caused efforts to use the bridge as a roadway for vehicles and animals, as well as pedestrians, and as early as 1371, a roadway was in operation upon the projecting courses at the top of the lower row of arches, sufficient width being obtained by recessing the bottoms of the piers carrying the intermediate row of arches. Because of the insufficiency of this roadway, the Languedoc States decided in 1743 to build a new bridge across the river against the eastern face of the adjacent structure. The construction of this new bridge was begun in 1743 and completed in 1747 under the direction of Henri Pitot, member of the Academy of Sciences, entrusted with the preservation of the public monuments of the district.

Structure Restored

At the time the new bridge was constructed, no work of restoration of the ancient structure was undertaken although it had suffered the ravages of time and many of the stones had lost their solidity, threatening ruin. Another hundred years elapsed and then Pros-

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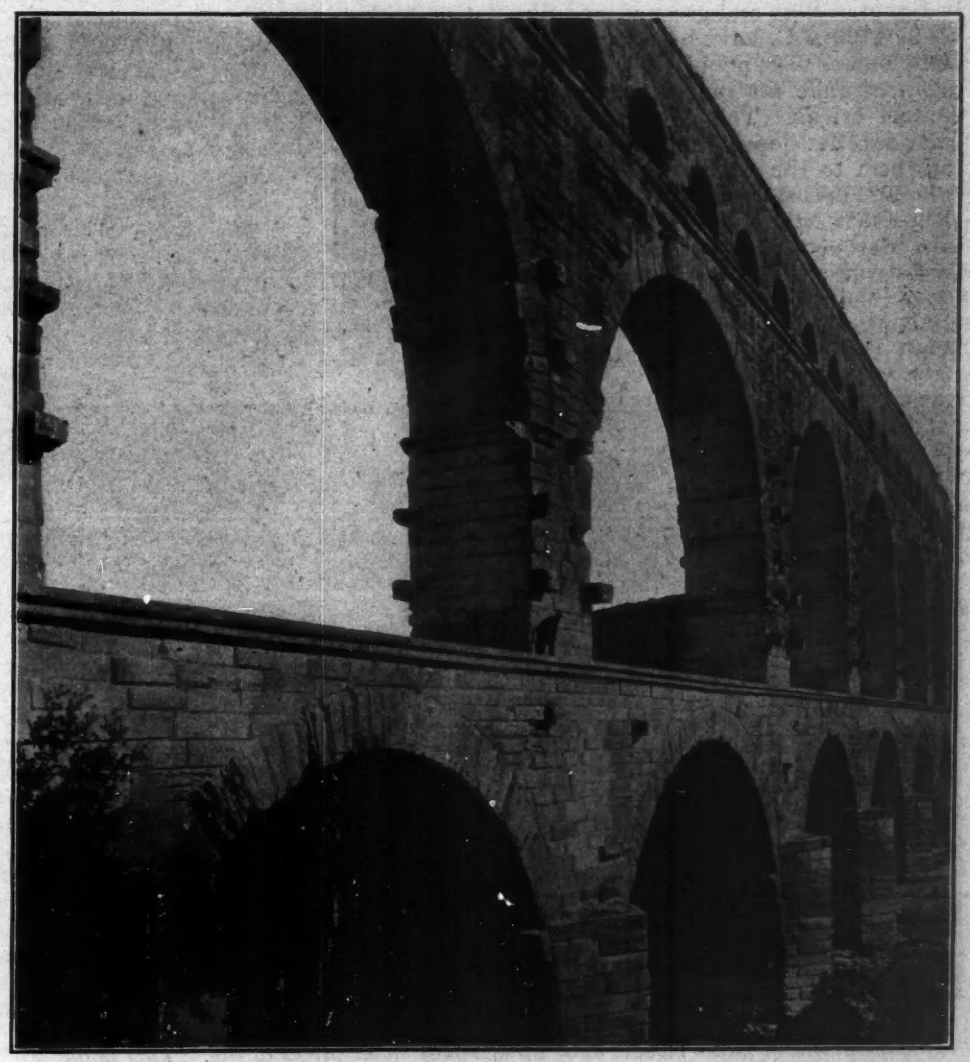


View of the arch construction. Note projecting stones upon which centering was placed. Voussoirs were laid dry.

Modern Tile Development

BY DOUGLAS DUNCAN

Advertising Manager, Mosaic Tile Company

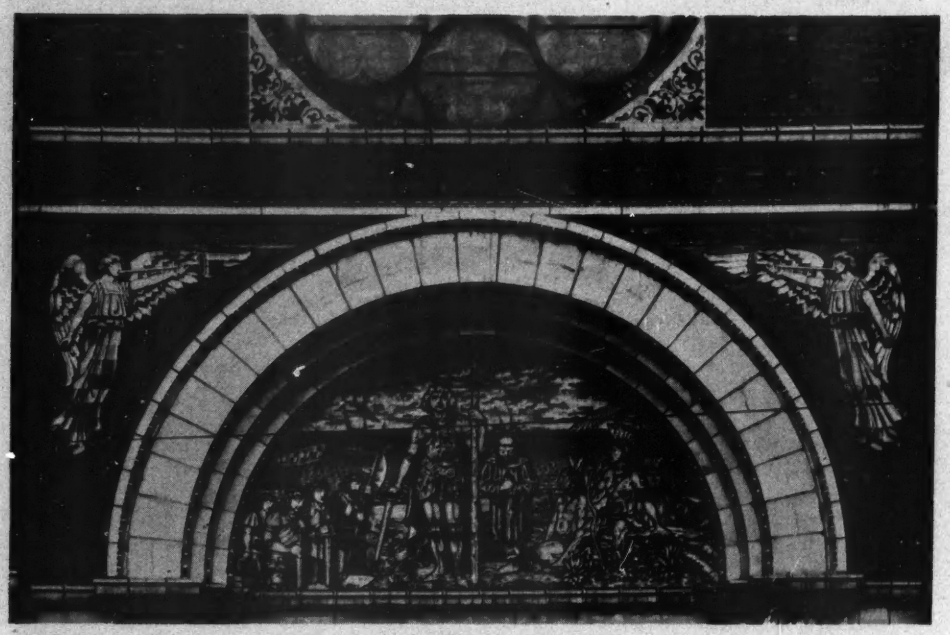
CERAMIC TILES — tiles of clay, moulded and fired to age-long permanence are almost as old as architecture itself. Just when primitive man —making his rude houses and vessels out of sun-dried clay — learned the effect of fire on earth and produced the first pottery — we do not know. But we do know that nearly every early race that has left any traces of itself at all, has left fragments of pottery.

Thin slabs of sunbaked clay were the first architectural form of pottery. Burned slabs were first used as a veneer and protection for the thick mud walls of the more important houses. Gradually these slabs became the object of decorative treatment. The possibility of glazing clay objects was discovered. In this way ceramic tiles were developed. So beautiful in color and design are some of the tiles made by the early peoples that even today, in the light of all our scientific knowledge, they seem truly remarkable.

The first Ceramic tiles that we know of were used in Egypt. Blue and green glazed tiles dating back as far as 4700 B.C. have been found near Thebes. The Babylonians also, about this same time, were developing a ceramic art in the form of decorated colored enamel bricks. The Assyrians and Persians at an early date developed some very remarkable tiles, applying them to the architecture of their palaces to add color and decoration. The militant Saracens who had their rise in Arabia spread through Syria and eastward into Mesopotamia through Persia and into India and westward through Egypt and North Africa into Spain. From Spain the art of tile making spread to Italy, to Holland, to England, to Mexico, and to America. While the Ceramic art of Mexico has had some influence on the Pacific Coast, being responsible for the spread of Spanish Mission architecture, it has had very little influence upon the present Ceramic industry in the United States.

The art of the potter in the United States had first to do with the making of jugs, bottles and queensware and the manufacture of tiles in a modern sense seems to date from the efforts of Samuel Keys, an Englishman, who, while managing a brick works at Pittsburgh, Pennsylvania in 1867, conceived the idea of entering the tile manufacturing field and began experiments which by 1871 yielded such successful results as to receive a certificate at the Pennsylvania Agricultural and Mechanical Inter-state Fair. The firm which he organized under the name of the Star Encaustic Tile Company, began tile manufacture seriously in 1876 when a plant was erected on Bluff Street, Pittsburgh. The next year saw the establishment of a plant for the manufacture of encaustic tiles at Zanesville, Ohio; this to be followed within the next decade by the opening of tile manufacturies in Indiana, Massachusetts, New Jersey, Kentucky and Pennsylvania. Then followed the gradual establishment of other plants in the states named and in such states as West Virginia where good clay deposits were found and New York and as far away as the Pacific Coast. Thus was built up an American industry comparable with that in any modern country.

Today in this country tile is more popular than ever. Go into any section and you will find the enduring beauty of tiles in outstanding homes, buildings and institutions. The vogue for tile is constantly growing, because of its qualities, gleaming colors and genuine economy.



Encaustic inlaid panel mosaic built up of many small pieces of tile. This is an example of the type of tile first produced in the United States.

Classification and Description

Many people, when they hear the word "tiles," visualize either the plain white glazed tiles used so widely on bathroom walls or the small mosaic tiles (technically known as ceramic mosaic) which have been so wonderfully developed as a material for floors. Many other varieties of Ceramic tiles have been perfected by the tile industry in the United States within the last twenty-five years.

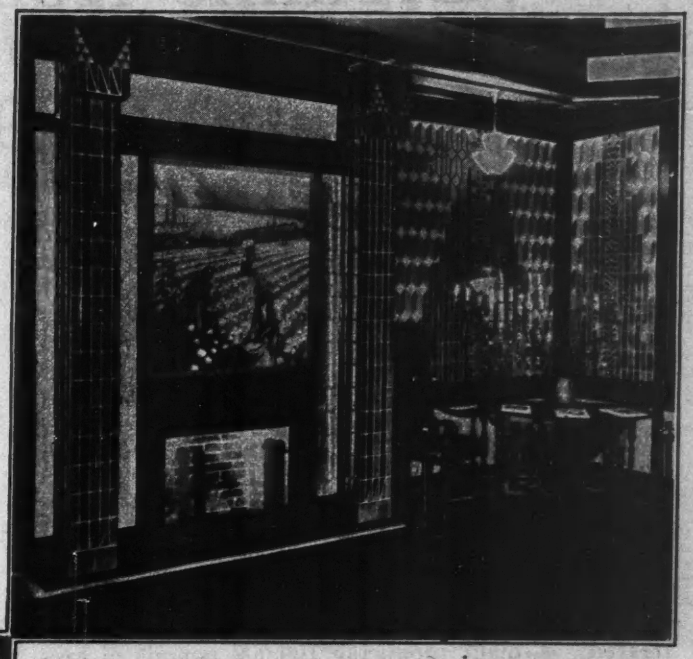
According to the process used, Ceramic tiles of today fall into two general classifications—plastic and dust-pressed tiles. With plastic tiles, the moist, plastic clay is pressed into dies or moulds. With dust-

pressed tiles, the materials are grouped up, mixed with water, dried and finely pulverized before being pressed into metal dies. White glazed tiles are the best known dust-pressed tiles. They have a white body and a bright finish, transparent glaze, and are immensely popular for bathrooms, kitchens, laundries, for any use where the utmost in cleanliness and sanitary finish is desired.

Enamel tiles and Satin Matt wall tiles have a dust-pressed body, coated with a colored glaze. Because of their practicality and their beautiful range of colors they are now the most popular of all classes of tiles. They are made in 4¼" x 4¼", 6" x 3", 3" x 3" and 6" x 6" sizes.

Ceramic Mosaic is a collective term for unglazed, dust-pressed tesserae ¼" thick in sizes ¾" squares, 1" hexagonal and 1 3/16" squares, 2 3/16" x 1 1/16", 1 9/16" x ¾" and ½" squares. They are made in a variety of small sizes and in almost every conceivable color. Wonderfully rich designs can be achieved by combining different shapes and colors of ceramic mosaic.

Faience tiles are the best known plastic tiles.



These views illustrate the use of tile to secure modernistic effects. The treatment is mosaic faience of special design.

They are beautifully glazed tiles, with the slight pleasing irregularity of surface, characteristic of all plastic tiles and are made in a great variety of colors, shapes and sizes. Special shapes and decorative designs are easily made in faience.

These are only a few of the many types of Ceramic tiles now being made in America. Other important kinds are flint tiles, vitreous, semi-vitreous and hydraulic tiles.

Tiles owe their qualifications of durability and permanence to the intense heat at which they are fired. Mosaic wall and floor and faience tiles are produced at temperatures of about 2100°F. Most of the flint floor tiles and ceramic mosaic floor tiles are thoroughly vitrified so that they are absolutely non-absorbent. This is also true of mosaic faience tile, making it practical for exterior use. The white and colored wall tiles do not have a vitreous back, but with their high fire glazed surface are extremely practical for interior wall use.

Tests of Floor Tile (Unglazed)

In a report entitled "Condition of Floors after Continued Service," issued by the Mellon Institute of Pittsburgh, interesting results are given of a number of experimental tests, in which Ceramic tiles were compared with other materials in their resistance to heat, moisture, chemicals, abrasions, etc.

The ten other materials tested with them were slate, marble, terrazzo, asphalt, wood, rubber, cork, linoleum and two classes of cement.

In the heat test, Ceramic tiles were absolutely uneffected at a temperature of 1650°F. whereas wood, rubber, cork, and linoleum were effected at temperatures from 140° to 570°.

In the wear test, Ceramic tiles also stood high, showing a loss of only 4.5 per cent to 15.3 per cent under severe abrasion, whereas wood, rubber, cork, and linoleum showed a loss of from 19.8 per cent to 72.0 per cent in weight.

Ceramic tiles were the only material that showed absolute resistance to chemicals. They also stood in Class A in the moisture test (where they were soaked for four months in water), showing no deterioration whatever, whereas rubber, wood, cork and linoleum ranked respectively in classes B, C and E.

"Tile floors . . . . are very resistant to wear, stains, chemicals and fire," was the conclusion of this scientific report. "They are economical . . . . are inodorous, and do not rot, fade, harden, soften or deteriorate from exposure to sunlight, moisture or temperature."

One experiences more and more the satisfactoriness of Ceramic tiles as the years go by. Where other materials have to be repaired and renewed at a cost of time and money that often equals or even exceeds the first cost of installation, Ceramic tiles, after a generation of use, look as lovely in color and texture as when they were first laid.

Wide Scope of Application

Ceramic tiles adapt themselves to the architecture of almost any locality and to the purpose and character

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Bromine from Sea Water

BY DONALD G. FINK '33

THE use of bromine in the manufacture of ethyl gasoline has recently created a new demand upon the commercial resources of the element. Since the only practical source of bromine has hitherto been the bromides recovered in salt mining, it became apparent that this new demand might eventually exhaust the supply. As early as 1924 researches were started to determine the possibility of obtaining large amounts of bromine from other sources. The fact that sea water contained appreciable amounts of the element had long been recognized, but the problem of an economical process for recovering it on a large scale had not been given serious consideration.

In his voyages in 1876, Dittmar pointed out that the composition of sea water is remarkably constant, and showed that bromine appears to the extent of from 60 to 70 parts per million of water in practically all undiluted ocean water. This extremely minute concentration is capable of supplying enormous supplies of bromine when large amounts of sea water are treated. A plant producing 100,000 pounds of bromine per month would require 392 years to exhaust the bromine present in a cubic mile of sea water. This fact, coupled with the size of the oceans, means that treatment of sea water for bromine opens up an inexhaustible supply of the element.

The Tribromoaniline Process of Recovery

The most feasible process for recovery was developed in the laboratories of the Ethyl Gasoline Corporation in 1924. It uses an aniline compound as an extracting agent, through the formation of tribromoaniline, $C_6H_2Br_3NH_2$. Since bromine occurs in sea water in ionized form, it was first necessary to create a molecular form. Chlorine, used to displace the bromine, proved successful for this purpose. The process thus consisted of three essential treatments, expressed in the equation:

$$3Br^- + 3Cl_2 + C_6H_5NH_2 = C_6H_2Br_3NH_2 + 3H^+ + 6Cl^-$$

Several factors enter into this equation, however, which require auxiliary processes to produce the highest efficiency, and to obtain a uniform product. An excess of chlorine is necessary to take care of any formation of hydrobromic acid in the aniline process. To prevent the ionization of this extra chlorine as HOCl, extra H ions are added from H_2SO_4 to depress the hydrolysis. Hence an acidulation treatment of the sea water with sulphuric acid is necessary to high speed production. The tribromoaniline process thus becomes:

(1) Acidulation of the sea water with H_2SO_4
(2) Displacement of Br molecules with chlorine
(3) Reaction of Bromine molecules with analine (or aniline salt)
(4) Recovery of free bromine from the tribromoaniline thus formed.

For successful operation, close control over each reagent is necessary, and the reagents must be mixed properly and quickly to avoid loss through oxidation.

Laboratory Development

Synthetic sea water was first used to determine the probable yield in large scale production. Yields as high as 70 per cent were obtained in this manner, and although subsequent large scale operations did not equal this upper limit, the results warranted the installation of a semi-works plant. A small experimental station was set up in Ocean City, Md., for the purpose of developing the process for commercial uses. It became immediately apparent that extremely high speed treatment was necessary to yield worth while returns, and the further development consisted largely in devising means for treating great quantities of sea water accurately and at extremely high speed. That this was no small problem is evidenced by the fact that for a recovery of 100,000 pounds of tribromoaniline in 25 days (the average length of a sea works voyage) 7,000 gallons of sea water must be treated every minute. Special equipment for practically instantaneous mixing was found to be capable of handling this amount of water, and it only became necessary to accurately control the amount of each reagent. Injectors of H_2SO_4, chlorine, and aniline sulphate, into the mixing chambers were used for this purpose. The yields in this experimental plant showed several interesting facts. 47.6 per cent tribromoaniline was recovered, there being present 45.1 per cent ash, and 7.3 per cent of organic material in a typical analysis of the filter cake. Of this large amount of ash the greatest part was sand, mixed with a smaller amount of iron oxide. Considerable trouble was experienced with the filters, a difficulty believed due to the presence of very fine sand which is always present in suspension at the sea shore, and to the organic matter discharged into the ocean by the rivers along the coast. This fact, together with the necessity of flexibility in scene of operation, suggested the latest phase of the development. A ship fitted out as a large scale producing plant was finally decided upon as the best method of eliminating filtration and dilution difficulties.

Large Scale Operation—The S. S. Ethyl

A steel lake-type cargo steamer 253 feet long and 43 feet beam was accordingly purchased and converted at Wilmington, Del. into a floating chemical plant. The test of the essential chemical machinery proved successful and all details were completed less than four months after its purchase.

The size of the equipment was based on a desired recovery of 100,000 pounds of tribromoaniline per voyage. The assumption that water contains 70 parts per million of bromine and that a yield of 70 per cent is possible demands a rate of treatment previously stated; 7,000 gallons per minute. In order to supply the demands of this treatment, a storage capacity of 500,000 pounds of 66° Baume sulphuric acid is necessary. Steel tanks placed between decks were used to store this acid. 50,000 pounds of aniline (to be transformed to aniline sulphate at the scene of operations due to the latter's greater solubility) were similarly stored in steel tanks. To reduce bulk, liquid chlorine was used, in one ton tanks to a total capacity of 66 tons. These amounts were calculated on the basis of the average contemplated voyage of one month. The extreme danger of escape of either the acid or the

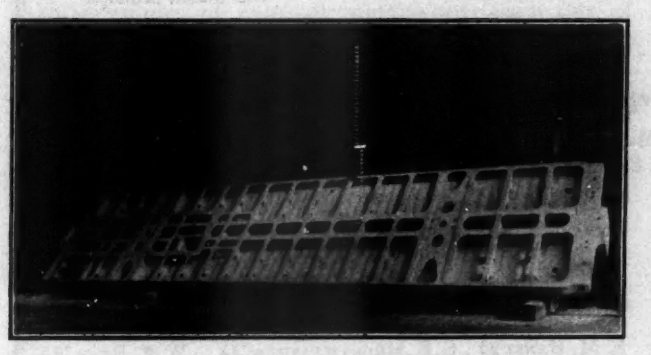
(Continued on page 66)

Cast Steel Foundations for Railroad Equipment

BY J. C. TRAVILLA, JR.

General Steel Castings Corporation

ANYONE who stands along the right-of-way of one of our larger railroads and watches high speed passenger or freight trains roll by, must wonder that the cars do not fall apart before they reach their destination. The service given by this equipment is quite remarkable considering conditions under which it is operated, and it must necessarily be of very sturdy construction. Its development has progressed as operating speeds have been stepped up.



Large casting of 22,500 gallon water tender frame.

Not so very many years ago passenger truck frames and car bodies, as well as most other railway equipment, were made of wood. This was followed by built-up steel construction, which has in turn been superseded to a large extent by cast steel.

The development and use of steel castings in railway equipment has been gradual. At the beginning of the present century cast steel for railway rolling stock was limited to relatively small castings weighing in the neighborhood of 100 pounds each. These were used in conjunction with wood or structural metal all bolted or riveted together, and required frequent maintenance which was costly, not only because of direct labor expended, but because of the time lost due to rolling stock being kept out of service for repairs. This naturally led to the idea of reducing the number of parts to a minimum by using one casting in place of a number of built-up parts wherever possible.

First Large Casting Successful

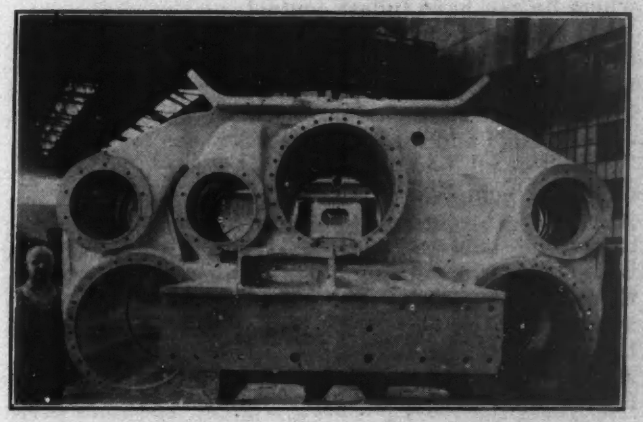
Probably the first larger casting of importance was a passenger car truck frame, which was made about twenty-five years ago. This device has proven so successful that it has been adopted by practically all railways, and by the Pullman Company as a standard of construction. One of the greatest advantages of a cast steel truck frame on passenger equipment is that it increases the safety of operation. Much progress has been made in railway safety work and a considerable part of this may be attributed to the excellence of equipment and high standards of maintenance which the railways have attained. As the safety and economy of cast steel devices were recognized by railroad men, the field of development was limited only by the ability of foundries to make larger and better castings within a price range which would permit their use. The progress which has been made is best indicated by the size and complexity of present day cast steel products, such as locomotive beds and water bottom tender frames.

The first steam locomotive bed was made about six years ago. It substituted a cast unit in place of main frames, rear frames, cross ties and brackets bolted together which had previously comprised the built-up frame construction. This bed frame has been in continuous use on a passenger locomotive since its application and has given excellent service. The desirability of this construction has caused the railroad for which it was made to order several hundred of an improved design having the steam cylinders and brackets for application of auxiliary equipment cast integral. The integral cylinders are especially desirable because the reciprocating action of pistons tends to work cylinders loose from the main frames, and with fabricated frames the bolts are constantly working and must be replaced in enlarged reamed holes. This trouble is entirely eliminated when cylinders and frames are made in a single casting, and in addition to doing away with the bolted connection, a more economical distribution of metal can be made, and for equal weight much greater strength obtained. These advantages were quickly recognized and there are now several thousands in service on different railways throughout the United States and Canada, and some have been shipped as far as Australia.

Integral Castings Minimize Repairs

The use of a cast steel tender frame is not new, as it was one of the first large railway steel castings developed, but the earlier type was simply a skeleton frame to which was attached a tank or cistern. The

(*Continued on page 59*)



Head on view of locomotive bed showing cylinders cast as a part of the frame.

· THE TECH ·
ENGINEERING NEWS

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Editorials

Expressing Engineering

A survey of activities of Technology graduates shows that a large proportion of them leave the pure engineering field and go into administrative or executive positions. This is just another indication that the public is realizing more and more that the technically trained man has become indispensable to modern civilization and is therefore putting him into positions where he can have fullest control.

To properly fill or even to attain to such a position, the engineer must possess something besides his technical knowledge. He must be able to present that knowledge and his views to others in language which is intelligible and interesting.

First of all, he must be able to speak interestingly and convincingly. Many students believe that engineering subjects are too dry to be made interesting in a public address and that there is no use trying. This is not true. Any subject can be made interesting if properly handled. The story is told of Gladstone speaking in the British Parliament for four hours on the budget, probably the least interesting of all topics, and holding his audience almost breathless during all that time. Daniel Webster's great speeches were mostly on the fine points of constitutional law, surely as unintelligible and uninteresting to the layman as anything could possibly be. If he would succeed to responsible positions, the engineering student must try to emulate these men and be able to present technical subjects intelligibly to his listeners.

Perhaps even more important is the ability to write clearly, concisely, and to the point. Engineers are frequently called upon for reports or articles to be presented to non-technical readers. There is no better way to develop a lucid, concise style than to study the masters of literature. Their writings have become classics because they say worthwhile things in a manner which cannot fail to be understood. It would pay anyone to make a study of Aesop's fables — whole stories told in a paragraph or two — as a lesson in brevity.

To acquire a good, coherent style is not always easy but it can be done. Benjamin Franklin relates that in his early years his style was very poor. He made a study of Joseph Addison's writings and was able to improve it so much that his scientific writings on his discoveries and inventions made him famous throughout Europe and America. His autobiography is a fine example of clarity and brevity.

Speaking and writing are probably the weak points of most engineers. They have no time for these fields which they consider irrelevant. The consequence is that they have to get someone else to present their

views or write their articles — at best a poor makeshift and almost always unsatisfactory. A little study and patience should enable anyone to acquire these two invaluable assets.

Efficiency?

We pride ourselves on our efficiency.

In America, particularly, the business and industrial world makes a fetish of efficiency, everything must be done in the most efficient way — we have efficient office boys, efficient stenographers, and efficiency engineers. We hire men to stand over a laborer with a stop-watch to time his movements and work out a system whereby a tenth of a second may be eliminated and save the company some thousands of dollars. We do all sorts of things to take up the slack in a myriad minute ways.

We take pride in these small accomplishments and call ourselves efficient. But are we? There are many examples of colossal inefficiency, each one of which is enough to wipe out the many small things we have done. The incandescent light, for example, is considered to be a very efficient source of light. Yet, of all the energy in the coal used to run the dynamos, only ten percent is utilized as electricity. In the light, only five percent of the electricity is converted into visible light so that from coal to light there is an efficiency of approximately one-half of one per cent. Obviously, there is still room for some improvement here.

We marvel at the huge buildings which climb higher and higher into the skies. Yet, any builder or designer will say that these structures are overdesigned, most of them containing enough material to erect two buildings of the same size. We do not yet know how to use all our materials to their full extent, or how to put them together properly.

The oil industry is the classic example. With the market already glutted, oil is feverishly pumped out from underground and then stored in expensive tanks ready to go up in smoke at the first opportunity, merely because there is no market for it. The natural gas found with most of these wells is allowed blithely to escape into the air while in other localities coal is utilized to make expensive artificial gas, inferior to the natural gas wasted.

We may well pride ourselves on our efficiency — at being inefficient and wasteful of our resources.

Education — A Dead Level

No one will deny that we are a nation of faddists — faddists about diet, recreation, health, religion, heroes, and whatnot. Perhaps no single field has been so beset with fads and faddists, new methods and new ideas as that of education. One of the greatest of these fads and one which became an accepted standard was the democratic ideal. School for everyone with equal training and opportunity for all was the guiding principle, one for which some of the finest minds of the eighteenth and nineteenth centuries labored. Theirs was a great cause and the institutions that now stand as monuments to their efforts have done much for the classes which previously remained illiterate.

Yet with all its benefits, American education today is, in one outstanding respect, a total failure. In all too few instances is provision made in educational circles for the student of exceptional ability and promise. From the very first he is given work which, though difficult for others, is easy for him. He must spend a month on what he could assimilate in a week, a condition which rarely inspires any mental exertion. Thus society's most valuable asset, the person with intelligence, is neglected while his average classmates, who do not wish really to think and probably cannot, are the recipients of most of the teacher's efforts. Education has been lowered to the level of mass intelligence. It is high time for a general reform which will bring special training for specially gifted students.

Staff Changes

The Tech Engineering News announces the election of Charles E. Fulkerson as Circulation Manager, a position left vacant by the retirement of Gene Cary.

The Cover

Our cover this month is from a photograph by William Rittase of the lightning arresters on the power house of the Conowingo Power Development. The photograph was secured through the courtesy of "Worlds Work."

Archimedes

287-212 B. C.

The ancient city of Syracuse was the home of Archimedes, the most famous mathematician and inventor of antiquity. The son of an astronomer, he studied at Alexandria and then devoted himself to mathematical research. He himself set very little value on the ingenious mechanical contrivances which made him famous, regarding them as beneath the dignity of pure science. As might be expected, it was these machines with their impressions on the popular imaginations that figure largely in the surviving traditions about Archimedes. He devised war engines and constructed burning mirrors for use in setting fire to an enemy's ship from some distance. The most famous story we have is the one telling of his discovery of the principle in hydraulics which bears his name. King Hiero gave him a crown purported to be made entirely of gold, asking him to make sure it contained no alloy. Archimedes was puzzled for some time over the problem, but one day as he was stepping into his bath he observed the water running over and it occurred to him that the excess of bulk caused by the use of an alloy could be measured by putting the crown and an equal weight of gold separately into a vessel filled with water, and measuring the excess of overflow in the one case. He was so overjoyed when this happy thought struck him that he ran home without his clothes, shouting "Eureka"— ("I have found it.")

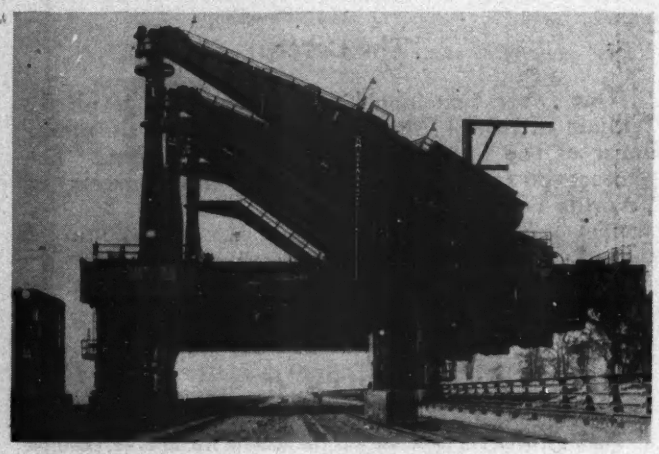
The reduction of mechanics to a mathematical basis must be credited to Archimedes. His pioneer work in mechanics is illustrated by the story of his having said, "Give me a place to stand and I will move the earth." He is said to have devised and installed a mechanical device by means of which a man could move a large and fully equipped ship by himself. The hydraulic screw which he invented was used to irrigate fields in Egypt and to remove water from the holds of ships. His greatest work was in geometry, investigating new fields and carefully checking ground already covered. He developed geometric processes amounting to integration by extending Euclid's method of exhaustion. He expounded, as applied to reckoning the number of grains of sand that could be contained in a sphere of the size of our "universe," a system of naming large numbers according to orders and periods which would allow any number to be expressed up to that which we should write as 1 followed by 80,000 ciphers.

Archimedes was run through the body by a Roman soldier at the fall of Syracuse, while engaged in drawing a mathematical figure upon the sand. His tomb was marked by the figure of a sphere inscribed in a cylinder, as he regarded his discovery of the relation between the volume of a sphere and its circumscribing cylinder as his most valuable achievement.

Engineering Notes

An Airship Mooring Mast has been built on the top of one of the newest skyscrapers in New York. To resist the side pull of a dirigible, the supports were especially strengthened. Each wall is braced with four outrigger trusses which extend the full height of the shaft. As the spacing of the columns of the tower is different from that of the building upon which it rests, a special base was necessary to carry the tower. This consists of a system of 72 inch plate girders.

In erecting the tower and the building it was found that 400 feet is the maximum economical lift of materials with present machinery. The hoist drums had sufficient cable capacity to lift goods 600 feet, but the principle limiting factor was the heating of the drums and snatch blocks. It was necessary to replace sheave bushings every few days. As the height of the top of the tower is 1,250 feet above the curb, it was necessary to use several successive hoists. In spite of these limitations, the 600 tons of steel for the tower were raised in fourteen days and completely riveted in seventeen days.



These giant unloaders are capable of handling tons of iron in ore operation.

Giant Unloaders recently put into operation show the progress in the design of massive machinery. Used for unloading ore, electrically driven by alternating current, these huge units pick up 17 tons of ore at a time and repeat at a period of 50 seconds. An operator, a weigher, and an attendant comprise the necessary crew for each unloader. These gigantic machines span four sets of railroad tracks and themselves move on tracks 7½ ft. apart. They travel about 50 to 70 ft. per minute. In operation, the dipper picks up the ore from the hold of a boat and places it in a 50 ton disk hopper which discharges into a traveling scale lorry. This car in turn dumps the ore into cars beneath the span. A small cab is provided for the operator directly above the dipper. Eight electric motors totaling 1060 horsepower operate each unloader.

The present installation consists of three stiff-legged hoists, each with a capacity of 1200 tons an hour.

A System of Atomic Weights with Helium as the basis has just been proposed in Germany. As the result of the discovery of the two oxygen isotopes, O^{16} and O^{17}, the reference value of the atomic weights, formerly having a single meaning, has split into a chemical one with O = 16, which serves as a basis of physico-chemical and chemical measurements, and a physical one with $O^{16} = 16$, to which spectroscopic results are referred primarily. This division will prove untenable in time. There is consequently a desire to return to the old reference value H = 1, which would however, involve a considerable change in all atomic wts. Aristid von Grosse of Germany therefore proposes referring the atomic wts. to He = 4.000. This system would theoretically be free from objections and would necessitate practically insignificant changes in the present table.

Induction Furnaces for a bronze foundry have been found very successful by a company which turns out large numbers of small, high grade castings. The strict temperature control and the accuracy of alloy composition made possible by this type of furnace render it highly useful where uniformity of product is necessary.

In this installation, the furnace shell containing the water cooled induction coils is so designed that it can be quickly raised or lowered. It is guided by two pillars, and the electrical connections are made through flexible cables. A car carrying two charged crucibles on a thick bed of sand is run under the shell, which is then lowered over one crucible. When the metal has been melted and raised to the proper temperature by the currents induced in it, the shell is raised, the car moved forward, and the casing lowered over the other crucible. While this one is heating, the first charge is poured, and its crucible refilled. Each charge weighs 190 lb., and the time of heating is about 18 min. As the induction causes stirring of the molten metal, the alloy is more thoroughly mixed in this than in any other method.

The furnace is very convenient to operate, the exterior being cool, and all the manipulation extremely simple. This method is very flexible, as it is possible to start, stop, and delay the operation of furnace to correspond with conditions on the pouring floor. There is little opportunity for the air to come in contact with the metal, and there are no gases used in heating. Hence there is very little chance of included gas bubbles. Likewise, there is a very low loss of metal by vaporization. Since the heat is generated in the metal itself, not outside the crucible, the charge is hotter than the container. Thus, the life of the crucible is considerably prolonged.

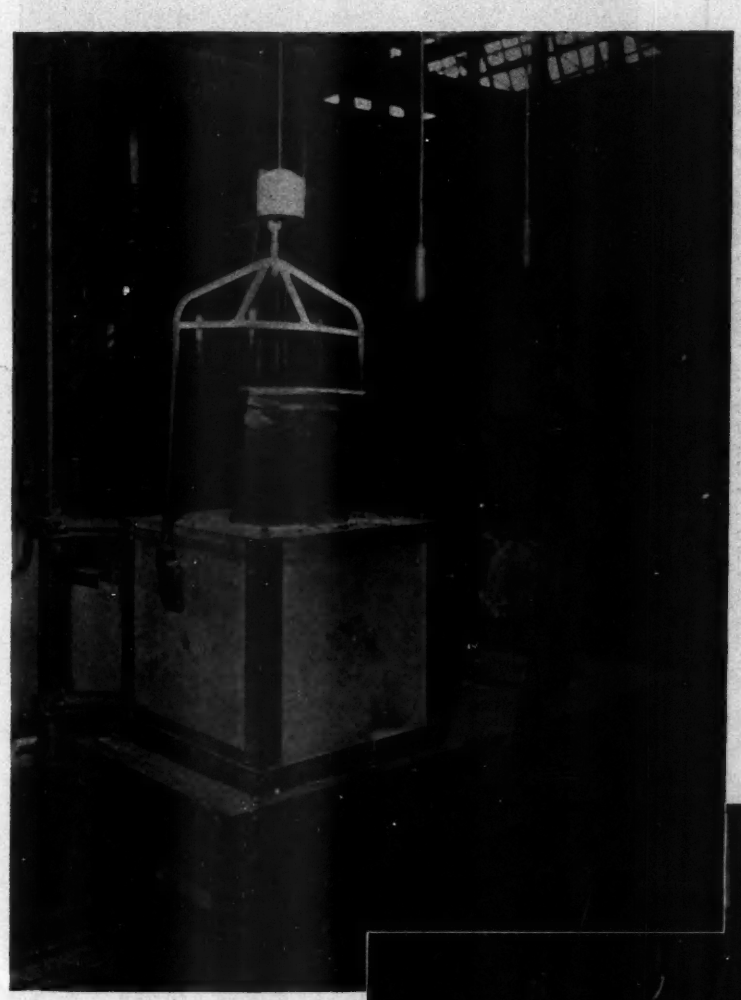
A Tube has just been displayed which may become of the utmost importance. Utilizing 650,000 volts, it emits rays quite comparable to those given off by radium, and one specialist calculated that with such a tube one might accomplish results that would be equivalent to those obtained with $5,000,000,000 worth of radium. There is no reason to believe that 650,000 volts is the uppermost limit, if there is any advantage in going higher, and it seems probable that the physicist can produce a tube with which results characteristic of radium can be obtained. Radium, which is considered one of the wonders of the modern world, may soon find itself reduced by the new competition to a place where it will be glad to be on speaking terms with a larger proportion of our population.

A Relay Truck of 275 H.P. has just been announced to the market-at-large. It has dual engines, six wheels, and a capacity of four to six yards of wet mixed cement or 5,000 to 10,000 bricks or tile in a single load. This new machine is claimed to be the fastest heavy-duty truck in existence. It is equipped with two straight eight cylinder truck-type engines with a combined power of 275 horse-power at 2800 R.P.M. The power is supplied to the drive in a way never before attempted. Each engine delivers power to a separate relay rear axle. The engines may be used in combination or one at a time, as each engine has its own transmission, an air mechanism shifting the twin transmissions in perfectly synchronized time. Safety is provided for with heavy-duty air brakes with cast iron brake drums and moulded brake blocks on all six wheels, with air connections for trailers. It also has twin emergency brakes. A hydraulic booster mechanism on the steering apparatus eliminates all steering strain and reduces the driver's fatigue to a minimum.

Arc Welding has been used in two buildings which are believed to be the largest thus far constructed by this process. One of the buildings is to contain testing laboratories and must resist considerable vibration. It is eleven stories high, the laboratories being on the first five floors. It is 220 feet long and 120 feet wide. More than ten miles of welding were used, requiring sixteen tons of welding wire. Three per cent of the steel necessary if riveting had been used was saved.

The other building is an office building addition measuring 184 by 95 feet. There is an inner court and the total height is 194 feet 4 inches. Bolts were used for erection.

Great care was used in the selection of the welders. Tests were given in which each man was required to make several welds of various types. These were then torn apart and examined. The factor of safety of the butt-welds was 4.05 and of the fillet welds 4.34. The work was carefully inspected in the field and occasional tests made of joints.



Courtesy, Metal Progress.

Above: The induction furnace lowered into heating position over crucible. When starting the heat the short "chimney" is filled with extra charge metal which sinks the crucible as melting takes place.

Right: Removing a completed heat. Note that the shell is ready to be lowered over second crucible.

PROFESSOR FREDERICK G. KEYES

Head of the Department of Chemistry

The Keyes Equation of State is known to students of thermodynamics and of steam and refrigeration engineering in this country and abroad, but the man whose name is attached to the equation is probably not known personally to the students of these subjects at the Institute, unless it happens that the students are those who have chosen to take some one of his courses. Professor Frederick George Keyes, Head of the Department of Chemistry, is not often to be encountered by one who is roaming the corridors of the Institute. His movements are more often vertical than horizontal. If he isn't in his office on the ground floor, seek him three flights higher up and it is likely that he will be found in his shop or in his laboratory — blowing glass, turning out something on the lathe, assembling an instrument of precision or making a part for it, taking readings or estimating results at the calculating machine.

Professor Keyes was born at Kingston, Ontario, in 1885. He received the B.S. degree from Rhode Island State College in 1906, the M.S. from Brown University in 1907, and the Ph.D in 1909. He stayed at Brown for a year as instructor, and in 1910 came to the Institute as Research Associate in Physical Chemistry. Here he remained until 1913 when he took on the duties of Chief Engineer of the Cooper-Hewitt Electric Company, a position for which his interest both in glass and in the behavior of gases eminently fitted him. In 1916 he returned to the Institute as Associate Professor of Physical Chemistry Research. The war intervened. In December 1917 he was commissioned Captain and in September 1918, Major, in the Chemical Warfare Service, U. S. Army. In 1918 and 1919 he was Director of the C. W. S. Research and Control Laboratory at Puteaux, near Paris, France, and rendered service for which he received a citation from General Pershing. Then, in 1920 he became Director of the Research Laboratory of Physical Chemistry at the Institute and in 1922 was appointed as Head of the Department of Chemistry.

Professor Keyes is the author of "The Thermodynamic Properties of Ammonia" (1916) and of many papers on physico-chemical subjects, particularly on the thermodynamic properties of matter, the kinetic theory of matter, and the applications of thermodynamics to problems of chemical equilibrium. One portion of his work has led to the development of the gas-operated refrigerator, and he has been granted a large number of patents pertinent to this and related subjects. His development, with C. A. Kraus, of boric acid glass of low coefficient of expansion, by which a graduated seal may be made between ordinary glass and quartz, has done much to facilitate scientific research. For the past eight years he has been engaged in securing precise data on the pressure-volume-temperature relations of steam up to temperatures as high as it is possible to go. The work is part of a general program for the revision of the Steam Tables, the other portions of the investigation being carried out elsewhere — on the Joule-Thomson cooling effect at the Harvard Engineering School, and on the specific heat of water, heat of evaporation, and mechanical equivalent of heat at the U. S. Bureau of Standards. A reduction of nearly one-half in the cost of the commercial production of steam has already resulted. Last summer Professor Keyes attended the World Power Conference at Berlin, Germany, at which these matters were discussed, and was gratified to learn that the results which have been secured at the Institute are in close agreement with those which have been found by the Reichsanstalt.

Professor Keyes is a Fellow of the National Academy of Sciences and of the American Academy of Arts and Sciences, an honorary member of the American Society of Refrigerating Engineers, and a member of the American Chemical Society, the American Physical Society, and the American Mathematical Society. Between administering the Department of Chemistry, directing research, and carrying out experimentation himself, he still finds time to know the students who are specialising in chemistry, to discuss their difficulties, and to formulate his own opinion of their particular abilities and aptitudes.

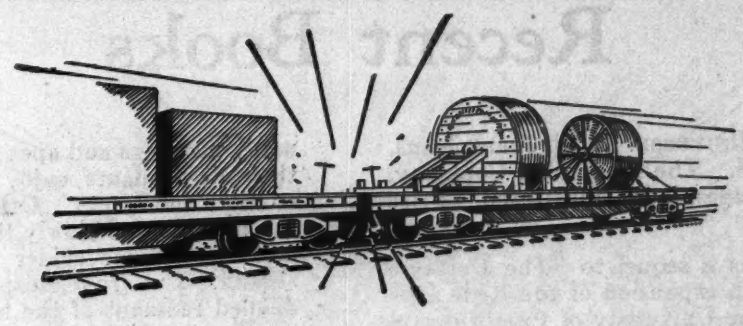
Departmental Notes

Department of Naval Architecture

A three-decker battleship designed for the Danish Navy in the year 1700.

The appointment of Mr. Magoun to Associate Professor of Humanics left a vacancy which was filled by promoting Mr. Beidelman to the rank of Assistant Professor of Naval Architecture. Mr. Beidelman who is a graduate of Course XIII came to the Institute to design the proposed Experimental Tank and having progressed well with this work he is now devoting considerable time to Navy Department duties.

The Nautical Museum has been enriched during the year by the addition of two historical models. The larger represents a three-decker battleship designed for the Danish Navy in the year 1700. All the drawings and specifications of this ship are in existence so the model is historically accurate, which unfortunately is seldom the case with models of old ships. This exhibit is a singularly beautiful piece of workmanship and is displayed in the entrance hall. The other model is that of the "Half Moon," the Dutch ship in which Henry Hudson, an English navigator, explored the Hudson River as far up as the site of the present city of Albany. This model has been made in accordance with such records as are available of Dutch ships of the period, and has been put in a case with similar models, namely Columbus' Santa Maria and the Puritan Ship Mayflower, forming a historical group of much interest to visitors.

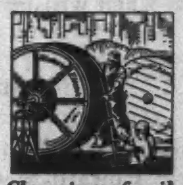


The cars that collided on purpose–

for a laboratory test!

Slow movies of the test caught what no eye could.

Crash! A flat car loaded with reels of cable slams into a standing freight train. A movie camera grinds away. Watching intently is a group of men — Western Electric engineers . . . What did such a test show? Just this — that the new steel reel for telephone cable does not break under severe impacts — and the old style reel may . . . The staging of this collision is just one more evidence of Western Electric's never-ending quest for certainty . . . It is a part, too, of a policy of giving new ideas a thorough trial — a policy which enables Western Electric to meet its ever growing responsibilities in the Bell System.



Changing a familiar scene. Steel reels replace wood.

Always open to new ideas and better methods.

Western Electric

Manufacturers... Purchasers... Distributors

SINCE 1882 FOR THE BELL SYSTEM

Recent Books

THE MYSTERIOUS UNIVERSE. By Sir James Jeans, M.A., D.Sc., F.R.S. The Macmillan Company, New York. 163 pages, index, illustrated. Price $2.25.

This book written as a sequel to "The Universe Around Us," contains an expansion of the Rede Lecture delivered before the University of Cambridge in November 1930.

The first four chapters deal with some of the theories and discoveries of modern science, setting them forth on very broad lines with brief discussions; as a preliminary, and to provide useful material for the fifth chapter. This chapter is of a different sort, for Sir James Jeans here presents the interpretations which he places upon these facts of science. He says of it:

> "This chapter merely contains the interpretations which I, a stranger in the realms of philosophical thought, feel inclined to place on the scientific facts and hypotheses discussed in the main part of the book. Many will disagree with it—it was written to this end."

This part of the book cannot but prove interesting to those interested as to the view point taken by one of the world's leading scientists in regard to the creation and final destiny of the universe.

The book is illustrated with modernistic plates, besides containing some of the conventional photographs.

Books by Sir James Jeans whether of a popular, or of a technical nature are equally valuable, for when writing for the layman he writes with as much care and accuracy as when writing for the scientist.

A. B. B.

PARADE OF THE LIVING. By John Hodgdon Bradley, Jr. Coward-McCann, Inc., New York City. 308 pages. Price $3.00.

Within the past few years scientists have been endeavoring to put some of their more technical work into a popular form, making possible its consumption by the average man on the street. "Parade of the Living" is an attempt of this kind. The object of books of this type is praiseworthy, for the greater spread and increased understanding of scientific concepts aids in education, and gives people a broader and more accurate view of the origin of the world, and the things we find in it today.

But these attempts at education through popularization are praiseworthy only so long as they are accurate, the author has no right to play with the truth. Better no education than false education. Take one instance in "Parade of the Living" in the chapter called "Tales That Dead Men Tell," beginning with the second paragraph:

> "Slowly the land rose, the climate grew severe, the trees languished. The simian paradise became a purgatory because the very existence of the tree dwellers was interwoven with the branches of their homes. Asia began to buckle in the middle as the Himalaya mountains were born. The ancestral forests were cut in two. Before the barrier rose to impassable heights, many monkeys and apes escaped to India, where their descendants enjoy life to-day in ancient comfort and safety. Others lingered too long in the northland. Slowly the mountains grew, the climate became colder and dryer, the forest shrank. Cut from escape to the south, the bedeviled remnant of the happy horde met death. Some starved with the dwindling of the trees and tropical fruits. Others tried life on the ground. But here were the teeth and claws of bloodthirsty enemies, and many weaklings succumbed. It is not surprising that but one of all the forms survived, a lone victor in an unfair battle. But this was the creature of destiny whom fate had chosen to be the father of humanity.
>
> The forerunner of man came down from the trees reluctantly and only as a last forlorn hope."

In these words the author gives a totally erroneous impression. He is expounding an obsolete hypothesis.

1. The author says that due to the rise of the Himalaya mountains many monkeys and apes were cut off by the mountain barrier and prevented from escaping to the south. This statement is contradicted by the available evidence. We know that instead of the Himalaya mountains forming an impassable barrier at any time, the fact was that they rose so slowly that the rivers originating north of the Himalaya mountains and flowing southward before the mountains were born continued to do so, cutting their way through the rising mountains. Thus although the Himalaya mountains themselves were higher than the water shed to the north of them, which these rivers drained, there were easy and free passes from the regions north of the mountains to those at the south at all times, making impossible the cutting off of any monkey or apes from the southern country.

2. There has been absolutely no evidence discovered north of the Himalaya mountains of the ancestors of man. All of the finds have been to the south. This is a second contradiction of Bradley's statement that the first men originated north of the Himalaya mountains.

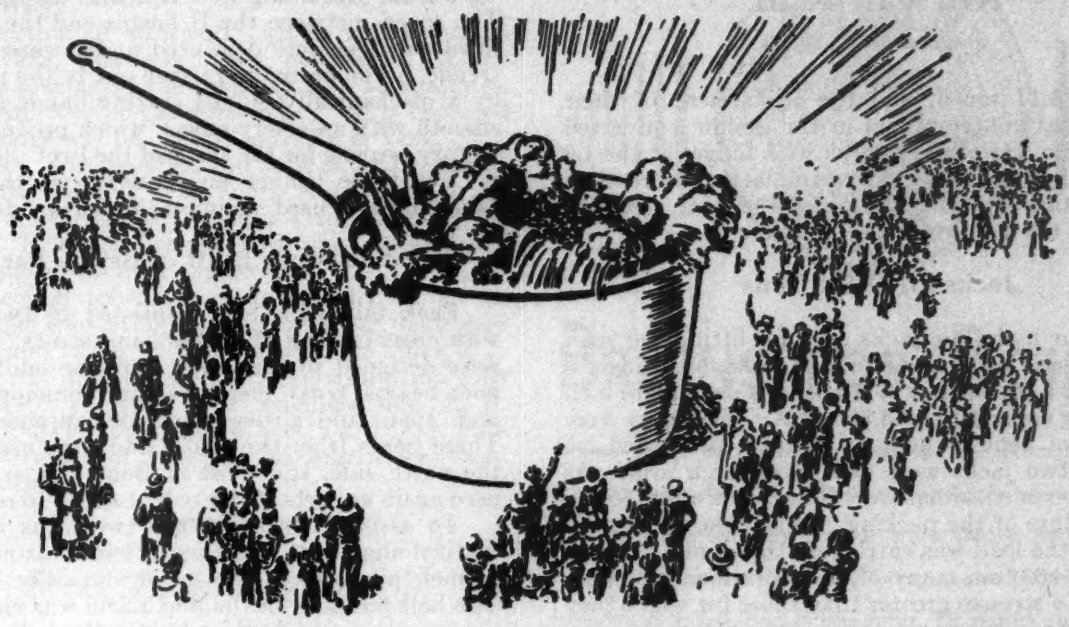
3. The statement is made that man's forerunners came down from the trees reluctantly due to the destruction of the forests, although there is no evidence of such destruction. They probably came down because of their higher mentality and the better hunting and easier living to be found as lords of the ground, because they were strong, not weak.

4. Even if we should grant the first three points, and supposed that many monkeys and apes were cut off in the colder northern regions, it would still not be necessary to postulate their destruction from that cold. Any change of climate was slow, and we know of many types today which flourish in cold climates.

This quotation gives an idea of some of the inaccuracies incorporated in this volume. It is replete with loose statements made with no supporting evidence or in contradiction to existing evidence.

Thomas Huxley said: "Scientific men get an awkward habit—no, I won't call it that, for it is a valuable habit—of believing nothing unless there is evidence for it; and they have a way of looking upon belief which is not based upon evidence, not only as illogical, but as immoral." According to Huxley this book would be classed as both illogical and immoral.

A. B. B.



Our twelve-billion-dollar pot

Since the beginning of time, cooking has been a family affair—each family for itself; a potful at a time. But the past decade has seen a great change. The old family cooking pot has gone the way of the old oaken bucket. And in its place is a new American phenomenon: the *twelve-billion-dollar pot.*

In this pot, 55,000 factories are stewing and brewing and preparing most of your food . . . and yours . . . and yours—an annual production of almost twelve billions of dollars.

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Kill van Kull

(*Continued from page 42*)

in Panel 13-14 south, and the adjustment of their stress to that contemplated in the design, converted the span into a two-hinged arch with hinges at the L0 points. The bents and their foundations were then removed, and with the placing of the floor steel the erection of the steelwork was complete.

Jacks Lift 3,500 Tons

The four hydraulic jacks used for lifting the span had a diameter of 39 inches and a stroke of 24 inches. Working at a pressure of 6,000 pounds per square inch their lifting capacity was 3,500 tons. The jacks were moved from bent to bent as erection proceeded, so that only two jacks were needed on each arm. As jacking proceeded, shims were inserted as a protection against failure of the packing. When the jacks were not in use the load was carried on the shims.

During erection many of the truss members were subjected to stresses greater than those for which they were designed. Such members were strengthened in three ways: by increasing the area of the permanent section; by adding temporary reinforcement which was later removed; or by using silicon or manganese steel instead of carbon steel.

In the vicinity of Bent N16 it was impracticable to strengthen the upper chord members sufficiently. The truss was therefore reinforced for three panels each side of the bent by a toggle, consisting of a chain of heat-treated steel eyebars and a post over the bent. Hydraulic jacks in the base of the post were used to stress the toggle by a pre-determined amount as soon as it was erected.

The arch shoes when first erected were held in place by riveting them to steel anchor frames embedded in the concrete abutment. Special provision had to be made to resist the vertical reaction which the shoes carried during erection. This was done by extending each shoe on its lower side so that it would rest on a pair of beams placed on the edge of the abutment, thereby reducing the overturning moment to an amount that could be balanced by the weight of the masonry engaged by the anchor frame.

Pins Act As Rollers

To prevent the lower chords from pulling on the shoes because of a fixed-ended condition of the wind truss, the pin bearings were arranged so that the pins would act as rollers, permitting a small motion away from the abutment along a 10 per cent upward grade. A chain of eyebars, extending from the abutment to a point in the bracing midway between the two trusses, served to anchor the structure against an off-shore wind, and at the same time was sufficiently elastic to permit the required motion at the shoes.

Since the river bottom was rock, practically bare, piles could not be made to stand alone. It was therefore necessary to make the piers for the falsework in units that were large enough to be stable when standing on the bottom. For each of the smaller piers at Panel Points 1, 2, and 4, four steel shells, open at top and bottom, and filled with 12 x 12 inch vertical timbers were placed on the river bottom and braced together. The timbers were then driven to refusal and sawed off to the proper elevation. For the larger piers, at Panel Points 7, 11, and 16, similar steel shells were used, containing steel H beams driven to refusal. The spaces between the H beams and the shells were filled with concrete deposited under water through a tremie. The beams were then cut to the proper level by a mechanically guided cutting flame, and ground smooth with an emery wheel, which produced a satisfactory bearing for the shoes of the bents.

The three timber piers on the south side were taken out and used again on the north side.

Falsework Built of Bridge Parts

Each falsework bent consisted of two columns, with cross-bracing of eyebars and struts. The bents were designed so that they could be built largely of floor beams, truss members, and bracing from the arch span, and girders from the approach viaduct. Three bents from the south side were used again on the north side, and most of Bents N4 and N7 were used again as parts of Bents N11 and N16 respectively.

To assist in bringing the two arms into proper vertical alignment, the closing joint was made with a 16-inch pin, which was fastened to the south arm. The half pin-hole on the north arm was chamfered at the corners to guide the pin into the hole. A simple indicator showed when the ends of the arms were approaching each other in the desired direction, and as the jacks at Bents S7 and N16 were lowered, the proper alignment was maintained by regulating the speed of lowering in accordance with telephone instructions from an observer at the closing joints. In the transverse direction, alignment was ensured by guide castings bolted to the tops of the lower chords. A V-shaped nose on one casting engaged a V-shaped notch in the other, and brought the chords into exact alignment shortly before contact was made at the pin.

The ends of the pin were flush with the faces of the chords, and after closure splice plates were added, completely concealing the pin.

Three-Hinge Made Two-Hinge Arch

When swung, the span was a three-hinged arch with the inner hinge in the lower chord joint at Panel Point 14 south. This condition did not accord with the design, in which it was assumed that the hinge would be at the center. In converting the span into a two-hinged arch it was therefore necessary not only to insert the upper chords in Panel U13-U14, but to produce in them the stress they would have had under the design conditions. Calculations showed that by applying an upward load at Bent S7 this stress could be reduced to zero. A load of the proper amount was therefore applied by raising the jacks at S7, the upper chords were inserted, and their end connections drilled. On release of the jacks the span was swung as a two-hinged arch.

The erection of the floor involved no unusual problems. The work was performed simultaneously from the north end, using a small traveler moving southward over the floor, and from the center, using the arch traveler and working towards the south abutment.

26,000 Tons of Steel

The arch span contains 17,000 tons of steel and the approaches 9,000 tons. The heaviest pieces lifted in the field were the end bottom chords, each of which weighed 87 tons. Steel was delivered in railway cars, which were placed on car floats. The floats were

towed to the site and the steel was lifted from the cars by the traveler.

The erection of steelwork, which was begun in October, 1929, has now been completed. There remain the placing of the roadway slab and railings, and the completion of the approaches. It is expected that the bridge will be opened to traffic in 1932.

The bridge was designed and built under the supervision of the Port of New York Authority, O. H. Ammann, chief engineer, Allston Dana, engineer of design, M. B. Chase, engineer of construction, and R. T. Robinson, resident engineer.

The erection scheme was devised by C. G. E. Larsson, chief consulting engineer, and was developed under his supervision by the writer in the office of J. E. Wadsworth, division engineer, in consultation with O. E. Hovey, assistant chief engineer and J. B. Gemberling, division manager of erection. D. S. Fine was resident engineer and Dan McQuarrie was foreman of erection.

Steel Foundations

(*Continued from page 49*)

water bottom tender frame derives its name from the fact that the bottom of frame is also the bottom of the tank. With this type, the water space is increased by an amount approximately equal to the depth of the frame, and the center of gravity is brought lower. However, the important feature of this construction is that it eliminates leaks in the bottom of tanks, which in the past have resulted in corrosion of tanks and frames and have been a very expensive maintenance problem for railroad shop men. In the water bottom tender frame and locomotive bed we have castings which require much engineering skill in their design and manufacture. Much experimental work and many foundry developments were necessary before sound castings of this kind could be obtained economically, and the successful production in large numbers indicates the extent to which the foundry art had advanced.

Large steel castings are now used in ever increasing numbers on railway rolling stock of all types. They have been made up to 60 feet in length and weighing as much as 85,000 pounds. There is still an enormous field for further use of cast structures. This is gradually being extended as the steel founder and engineer improve the art. The market for castings for various parts of railway equipment is to an extent limited by the minimum thickness of sections obtained over the larger areas. Work is being done to reduce this minimum, and it appears that the future of railway steel castings lies, not so much in the production of larger castings, as in a vastly greater volume of large but relatively lighter castings.

Precision Pressure Gages have been developed to meet modern demands. All parts are of alloy steel and the spring is of chrome-molybdenum alloy which allows the gage to be operated continuously under maximum load without fatigue. The flanged case is of cast iron and is absolutely fume tight. The movement of the gage is all steel. It has cadmium-plated movement-plates, steel hairspring, and extra wide bearing surfaces. The dial and pointer are of stainless iron which effectually prevents decoloration. The gage will handle up to 1000 pounds per square inch.

BAILEY METERS

BRAINS FOR BOILERS

A few years ago when a steam power plant underwent a heavy load demand, grimy firemen would work feverishly to keep pace with the cry for more steam. By their back breaking labor, six men could bring twelve 100 H. P. boilers from bank to full load in one hour. Coal and air were fed to the furnaces with little regard to combustion efficiency.

In modern central stations, the conditions are vastly different. The huge pulverized fuel fired boilers need practically no human aid when equipped with Bailey Automatic Control. As the load changes, the correct speed changes are made on fans, fuel feeders and pulverizers. A 3000 H. P. boiler can be brought from minimum load to full load in less than 10 minutes time when necessary. Most important, however, Bailey Meter Control constantly maintains highest combustion efficiency consistent with economical operation.

Modern boilers can think—their brains are the Bailey Meter Control System.

Write for Bulletin No. 12

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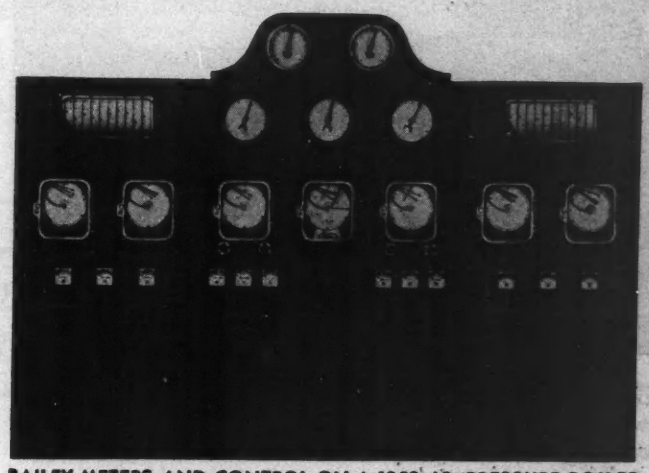


BAILEY METERS AND CONTROL ON A 1350 LB. PRESSURE BOILER

Tile Manufacture

(*Continud from page 43*)

Firing

After the pressing operation the tiles are carefully dried and prepared for firing by being placed in suitable fire clay boxes called saggers. The tiles are arranged in neat piles so as to guard against undue warfing of the flat surface, cracking, and other dangers encountered in firing tiles.

When the saggers are filled with tiles, they are placed on a movable car or conveyor which carries them into large furnaces or kilns. In the kilns there follows a period of firing at high temperatures which vary from two thousand (2000°F.) degrees to twenty-three hundred (2300°F.) degrees. The effect of this firing produces a hard vitrified body in the case of "floor" tile, and a smooth delicate surface capable of absorbing a subsequent coating of enamel in the case of glazed tile. In firing the tiles, they must be carefully heated to the high temperatures and then carefully cooled to room temperature. The firing in the kilns has been gradually reduced until it is now possible to fire tile in from seven to eight hours. In some of the tunnel kilns, it requires from four to five days to run a carload of tile through the kiln. The general adoption of the tunnel kilns in the ceramic industry has resulted in a great saving of time in the firing of clay products. It was formerly necessary to allow several weeks for the proper firing of tiles in the old "Beehive," or round type of kiln, which has long been associated with the ceramic industry and which has been supplanted only in the last few years.

Glazing

When vitreous floor tiles are being made, the process ends with the first firing except for the assorting and classification which all tiles must have before being packed for shipment. However, in the case of glazed tiles, the pieces must go on through a further processing equally as elaborate and complicated as the one just described.

This small down-draft gas-fired kiln is a part of the equipment of the Ceramics Laboratory of the Institute. It follows the general design of the old Beehive kiln and is well suited for experimental purposes.

The pieces to be glazed, upon coming from the first kiln, are called biscuits. These biscuits are coated on the exposed surface with a preparation which after subsequent heating becomes a hard and impervious coating of glass. This preparation is called the glaze. Glazes consist of mechanical mixtures of various compounds of calcium, lead, sodium, potassium, aluminium, silicon, zinc, barium, and other well known chemicals. These are wet ground in pebble mills to the consistency of cream. The pebble mills are rotating tanks which contain pebbles in them which break up the various minerals so that they are of the desired fineness for mixing to form the glaze. In the case of colored glazes and enamels, various mixture of copper, cobalt, uranium, iron, and other metallic elements are

A group of cars loaded with saggers full of tile ready to enter the tunnel kiln. The cars are attached to a continuous chain which draws them through the kiln.

employed to develop the many tints necessary for this age of widely diversified color requirements.

The glazes are applied to the tiles in various manners. In some instances it is applied by dipping the tiles into the glaze by hand. In other cases, such as flat floor tiles, the glaze is applied by passing the tiles through machines which have the glaze upon rollers. The latest and the best method is to spray the glaze upon the tile. The glazes are sprayed upon the faces of the tile by air operated spraying machines which are capable of glazing five thousand pieces of tile per hour.

After the glazing process has been completed, the tiles are subjected to temperatures of approximately 2000°F. in continuous tunnel kilns. The resulting tiles present a surface which is impervious to water, acids, and alkalies. Tiles are easily cleaned and sanitary, thus providing a permanent and substantial building material.

Many of the decorations that are often seen upon tiles used for decorating private residences or office buildings are applied by hand either before or after the glaze is applied. The decorating of tiles requires skilled artists who originate many beautiful designs that greatly enhance the beauty of architectural creations.

Because of their clean, radiant beauty, tiles have become more and more demanded for the modern architecture. This demand has caused the erection of huge plants to manufacture tiles, and has given rise to an industry that has a wider scope than many people believe. The scientific manufacture of tile requires that men be trained to thoroughly understand the manufacturing process. This has resulted in the establishment of Ceramic Engineering courses in several of our universities and colleges throughout the country. With trained engineers at the helm, the tile industry should progress further in the future than it has in the past.

The OIL INDUSTRY'S FUTURE *and Yours*

"With the exception of printing, no single industry has produced so many sweeping changes in man's mode of living as the petroleum industry."

AMPLE evidence for this statement by a leading authority is present on every hand. Yet the future of the oil industry promises to be even more amazing than its past. This means that well-established organizations like the Standard Oil Company of New York — whose activity covers every phase of the business — offer unusual opportunities.

Perhaps there is some branch of this business that appeals to you as a life career — either in this country or abroad. We require a limited amount of young men each year, of certain qualifications. Perhaps you possess these qualifications. At least a representative from our Personnel Division would be glad to give you an interview when he visits the Massachusetts Institute of Technology on March 23rd, 1931. The Director of the University Placement Service has information on file about our Company. Consult him in the mean time regarding any uncertainties which may exist in your mind; he will be glad to assist you.

STANDARD OIL COMPANY OF NEW YORK
26 BROADWAY, NEW YORK CITY

Pont du Gard

(*Continued from page 45*)

per Merimee, who had been appointed Inspector General of Historic Monuments of France, saw the structure and was so impressed by its grandeur that he decided it should be restored to prevent its further deterioration, and during the years 1843 to 1845, a slight amount of reconstruction, costing 12,000 francs, was executed. This work, however, was merely superficial, and after a careful examination of the structure, had been made, thorough repairs were authorized by Napoleon III. These repairs were completed in 1859 at an expenditure of 200,000 francs. At the completion of this work, a tablet was placed on the structure bearing an inscription which may be translated as follows:

> "This aqueduct constructed by the Romans to carry to Nimes the waters of the springs of Eure, repaired by the States of Languedoc in MDCCII, has been restored in MDCCCLV by the order of the Emperor Napoleon III and under the direction of the Minister of State. Charles Questel and J. Laisne, Architects."

This restoration was a delicate and difficult operation which involved the removal and replacement of defective material, including some of the arch voussoirs. It was, however, carried out successfully and the casual observer of today is not aware that the structure has been restored. Since the foregoing repairs were made, no further restoration has been found necessary.

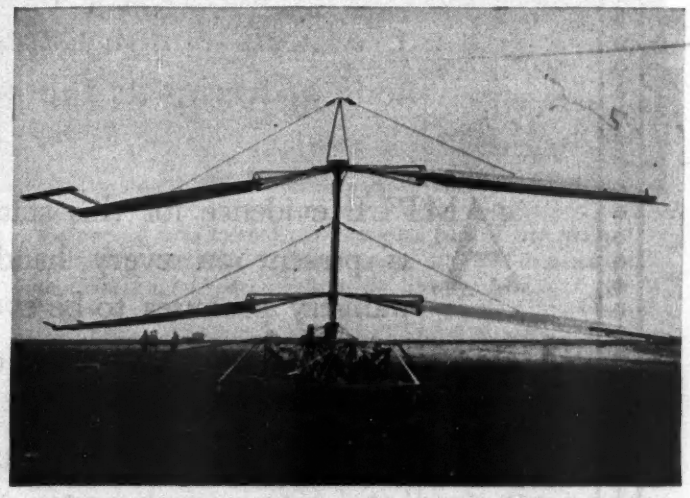
Famous Authors Describe Structure

This article may fittingly be closed by quotations from the works of two famous authors who visited and described this wonderful structure, Jean Jacques Rousseau, and Charles Kingsley. The former says in his "Confessions," published in 1793:

> "The Pont du Gard was the first work of the Romans that I had seen. I expected a monument worthy of the hands which had constructed it. For once, the object exceeded my expectations and this was the only time in my life. It was given only to the Romans to produce this effect. The appearance of this simple and noble work impressed me the more as it was in the midst of a desert. Silence and solitude rendered the object more striking and the admiration more lively . . . I said to myself, 'Why was I not born a Roman!' "

And the latter in one of his letters wrote as follows in 1864:

> "My first impression of the Pont du Gard was one of simple fear. 'It was so high that it was dreadful,' as Ezekial says. Then I said, again and again, 'A great people and strong. There hath been none like before them, nor shall be again, for many generations.' As, after fifteen miles of the sea of mulberry, olive and vine, dreary from its very artificial perfection, we turned the corner of the limestone glen, and over the deep blue rock-pool, saw *that thing* hanging between earth and heaven, the blue sky and the green woods showing through its bright yellow arches, and all to carry a cubic yard of water to Nimes, twenty miles off, for public baths and sham sea-fights in the amphitheatre, which even Charlemagne, when he burnt the Moors out of it, could not destroy. Then I felt the brute greatness of that Roman people . . . The masonry is wonderful, and instead of employing the mountain limestone of the hills, they have brought the most splendid Bath oolite from the hills opposite."



A helicopter of Italian design which consists of two rotors driven in opposite directions by a 90 horse motor mounted on a nickel-steel tinned tubed fuselage.

Aluminum has been used in twenty-one vertical rolling, or curtain type doors, with a view to speeding operation. The doors are 13 feet wide by 19 feet, 11 inches high, and weigh 323 pounds. The slats are of 19-gage sheet and the bottom bar is of extruded angle section. It is said that these doors weigh less than one-third as much as similar doors of galvanized iron, and can be operated three times as fast, because of the smaller gear ratio possible in the operating mechanism. These doors are unpainted, thus effecting a saving, and are expected to resist the sulphurous fumes, when used on round houses, better than iron.

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Made of extra quality cotton yarn, carefully inspected, and guaranteed free from all imperfections of braid or finish The colored spots are our trade-mark, used only with this quality.
We make braided cord of all sizes, kinds, and colors for all purposes, including sash cord, clothes lines, trolley cord, signal cord, arc lamp cord, and many special cords for special purposes.

CATALOGUE AND SAMPLES GLADLY SENT ON REQUEST

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A Feed Pump for locomotive boilers is driven by a turbine, the wheel of which is forged in one piece. The maximum operating speed is limited to 6,000 r.p.m. by a governor, but the turbine is designed to withstand a speed of 30,000 r.p.m. The turbine drives a centrifugal pump which is mounted as a unit with the turbine. There are no complicated control valves, the whole being handled by an ordinary globe valve in the cab. It is suitable for all except special, high-pressure installations. The water capacity is 9,000 gallons per hour.

Design of Valve Gears is facilitated by a model valve gear in the drafting office. One of the newest of such models embodies a number of interesting features. The design is such as to make it applicable to Stephenson, Walschaert, Allen, or any similar gear. Many of the parts are adjustable so as to accommodate various lengths of connecting rod, eccentric rod, etc. Distances between center of axle and center of cylinder of up to 16 feet can be accomodated. The eccentrics are aluminum castings with adjustable throw. A vertical drawing board is provided which moves with the slide representing the piston. The pencil moves vertically, its motion coming from the valve spindle, giving the valve ellipse.

Reversible Silent Chains of an utterly new type have just been patented and put on the market. The chain allows the direction of the shafts to be reversed and will drive with either or both faces. It is particularly adaptable to installation where lack of vibration is especially desirable and also where it is desired to drive several in different directions of rotation or to install a chain takeup device to operate on the back of the chain.

It is necessary in selecting sprockets for this chain to choose those with diameters which employ an even number of teeth when designed for the conventional single-faced chain, since every other tooth is removed in the reversible chain sprocket to permit the passage of the back of the reverse chain links in their travel over the sprocket. This reversible chain is designed for long life due to the construction providing full width of the joint bearing across the chain, not interrupted and reduced by spacing washers or inside plates.

T. E. N.

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an

IMPORTANT NOTICE

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APRIL ISSUE

Another Special Feature!!

OF THE

MATHEWS MODERNIZED HYDRANT

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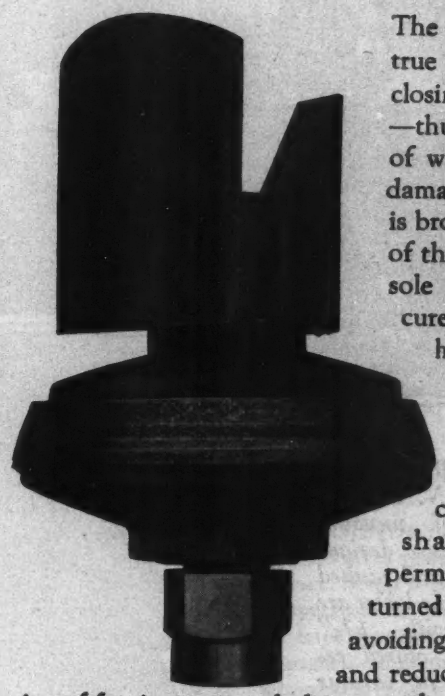
THE COMBINATION MAIN AND DRAIN VALVE



The main valve is the true compression type, closing *with* the pressure—thus preventing loss of water and resultant damage if the hydrant is broken. It is built up of the best oak tanned sole leather, held securely in place by a heavy bottom casting screwed onto the stem. It cannot work loose to leak or cause chatter. Being cone-shaped, the valve permits water to be turned on or off gradually, avoiding water hammer, and reducing the possibility of foreign matter lodging on the valve seat. Note the generously wide leather faced drain valve, assurance against leakage. It operates in a smooth bronze cylinder to prevent wear.

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CAST IRON PIPE AND FITTINGS

SAND SPUN (centrifugally cast) and PIT CAST GATE VALVES

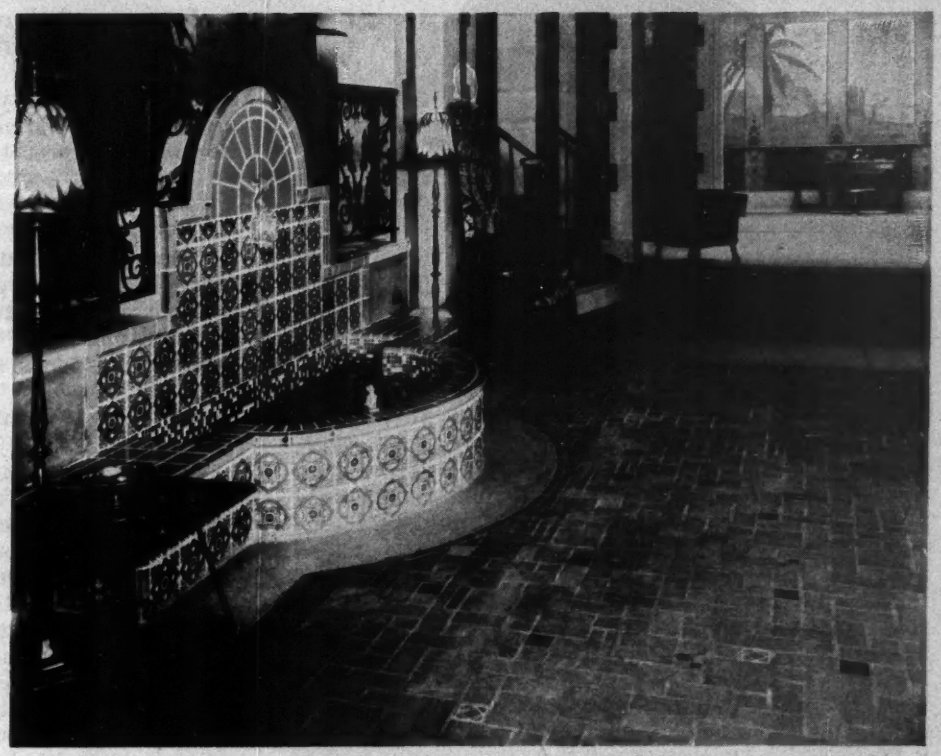
Reg. U. S. Pat. Off.

The City Building of Asheville, N. C. is a structure of unusual and distinctive design. The walls and vaulted ceiling of the lobby are surfaced with $1\frac{1}{16}$" squares of glazed ceramic tile in various shades of buff and brown. This glazed ceramic tile is a random mixture of several blending colors producing a variegated effect.

ARCHITECTURAL USE OF TILE

Tile Development

(*Continued from page 47*)



of almost any space. There is a wide selection of colorings and patterns in the conservatively priced ceramic mosaic floor tile, a number of Satin Matt and Enamel wall tile colors and several hundred faience colors with many sizes, so that originality can be given full sway in designing any treatment.

The wealth of superb colors in which tiles are to be had in almost infinite variety, has given them the wonderful appeal which they have for home owners and architects. This unlimited scope enables one to give character and individuality to a tile design employing the tile treatment to amplify the architecture of the building as a whole. It will be seen that proper tile treatments can be easily developed to suit homes and buildings of Spanish, Italian, French, English, Colonial or modern architetcure.

The historic background, manufacturing development, wide selection of types and colors, and adaptability to architecture, as outlined above have been responsible for the general acceptance of genuine tile as a building material, fulfilling varied requirements without practical substitution.

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Bromine

(*Continued from page 48*)

chlorine made necessary special bracing and supports of the steel tanks. Transportation of the acid from the storage tanks was accomplished by the use of compressed air. After being mixed to a solution of approximately 1 per cent it was injected into the acid turbulence chamber and was there completely dispersed in 3 seconds (at the rate of 8,000 gallons per minute). The dilution was then about 200 p.p.m. The liquid chlorine was expanded and led to the chlorinators through a steam heated evaporator. The chlorinators dissolved the chlorine gas in water and the resulting solution injected into the acidulated sea water stream. Complete dispersion (64 p.p.m.) was accomplished in 3 seconds. Aniline was also delivered by compressed air, to the sulphate mixing chambers where it was converted into aniline sulphate. The sulphate form was then delivered by air to the aniline injection chamber through 36 nozzles. Here the reaction took place, and in less than one second all of the available bromine was converted into tribromoaniline. This compound forms as a precipitate of crystals about .001 inch long and .0002 inch in diameter. From the reaction chamber the suspended precipitate is led to the filters, which are of the wood-plate Schiver type. The filter cake which results contains the tribromoaniline, to the extent of 80 per cent (in the dry cake). In order to handle the huge rate of flow, six filters are necessary, eight being provided so that one can be cleaned and another under repair during the operations.

The actual rate of flow used during the plant operation was 5,000 gallons per minute. The mixing and reaction at this rate required only slightly more than 10 seconds, and from the time when all chemicals had been added to the filter process was approximately five minutes. The final filtrate, slightly pink in color, was caught on 4,500 square feet of filtering surface.

Results of Tests

On the first run made under actual operation conditions, water was taken in at the rate of 4,750 gallons per minute, 67.7 p.p.m. of chlorine being present in the water used. Acid treatment to the extent of 223 to 500 p.p.m. was used, and 3,477 pounds of chlorine were consumed, per twenty-four hours. The aniline sulphate input was controlled to obtain the best conditions, that is, maximum cloudiness due to precipitate.

In a run of three hours duration, 493 pounds of crude dry product (filter cake) were produced. The bromine content of this product was 59.26 per cent, corresponding to a yield of 59.64 per cent. The ash, present to the extent of 45.1 per cent at the seaside works was reduced to 2.83 per cent.

Costs

The cost per pound of bromine, based on a 70 per cent yield and 68 p.p.m. bromine in the sea water treated is 17.7 cents. This cost includes only the essential materials, the other costs being difficult to compute due to the short duration of the trial voyage.

General Operation

The highly oxidizing action of the chlorine makes necessary rubber lined pipes, pumps and auxiliary equipment. The ferric oxide ash is due largely to corrosion of the exposed iron parts. The elimination of this difficulty presents no problem, though it was bothersome in the trial runs. The problem of rough weather on the voyage has been considered, and it is believed that the ship is capable of operating in anything up to a half-gale. The route of the ship shows that there is little choice between various locations as to the per cent of bromine present, but an axis of highest percentage has been plotted. Whether this axis is a constant quantity or is constantly shifting is not yet known.

Graham Edgar, chief of research at the Ethyl gasoline laboratories, and one of the leaders in the development, has stated that it is still more economical to obtain bromine for commercial uses from the salt mines. The newly developed sea water process will eventually become a most important source of supply, however, and it can be confidently said that the world need fear no bromine shortage for thousands of years to come.

Space for Carrying Mail in a large tri-motored airplane is now found in the wings. A hinged section between the ribs of the underwing is raised and lowered by a hand operated winch. A mail truck can back up to the wing and load its cargo directly to the wing container. The utilization of the wings as cargo space is proving very profitable as the passenger space is no longer decreased by the carrying of baggage in the fuselage. Plans for proposed planes in both the United States and Europe call for passenger space in the wings.

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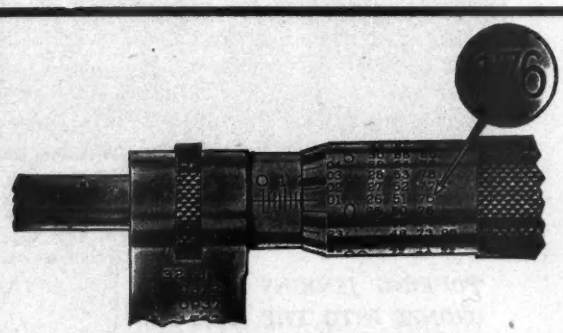

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Engineering Notes

A New Metal of extreme lightness and thought to be of valuable use to the aircraft industry is found in the salt waters in Michigan. These brines constitute the important raw material for magnesium production in the United States. The natural brine containing magnesium chloride is pumped from wells 1,200 to 1,400 feet deep. By a series of treatments, the other salts in the brine; namely, sodium chloride, sodium bromide, and calcium chloride are removed, and the remaining magnesium chloride is evaporated to a white powder, dried, and then fused in an electric cell where it becomes metallic magnesium. The most striking property of this new metal is its extreme lightness with a specific gravity of only 1.74, making it two-thirds as heavy as aluminum, one-quarter as heavy as iron, and one-fifth as heavy as copper. By proper alloying and heat treatment, magnesium alloys are obtainable in sufficient strength and toughness to compete successfully with other engineering metals. These properties, coupled with a high specific heat, and high electrical and thermal conductivity show many potential possibilities in various fields of application. Some of the more important uses of these metals in aeronautics are in crankcases, oil pans, seat frames, superchargers, instrument housings, control levers, impellers, pistons, and more recently in the development of forged propellors.

Besides their great aeronautic value, these new metals show a distinct improvement in performance when using them in many of the reciprocating parts of machinery.

A Dual Elevator System has been installed in a 20 story building. By this system, two elevators are operated in the same shaft. The upper car is an express to the 11th floor, the lower a local to the 10th floor. The two cars are so timed that normally they arrive at the tops of their respective runs at the same time, thus avoiding difficulty, but safety devices are installed to make a collision impossible. Each car has a signal showing the position of both cars. It is impossible to run the lower car up into the upper when it is below the 11th floor, or to run the upper down into the lower.

By the new system, much space is saved, which will return thousands of dollars in rent.

An Electric Gage which measures the one-hundred thousandth of an inch and magnifys the result 10,000 times so that the average workman can speedily and accurately read the result, has recently been developed. It consists essentially of a contact point supported to move through limited distance which is multiplied 10,000 times over the scale of the indicating instrument. Magnification is obtained by unbalancing a bridge circuit of four inductances. A 500-cycle altenator supplies power to the four inductances, two of which are situated in the gage head. The inductance is varied by the movement of a pivoted steel lever armature, one end of which moves between the coils as the contact point on the other end conforms to the surface of the piece being measured. The contact point is in the gage spindle which is made to fit the work. The other two inductances of the bridge are mounted in the indicating unit.

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Among Our Authors

MR. F. JAMES McNIFF is well qualified to write on the subject, "Corrosion and Heat Resisting Steels." For the past several years he has been connected with Industrial Steels Inc., and was formerly associated with the General Electric Co. He has made an intensive study of alloy steels and their applications to modern industry during his latter connection. He is a young man and by concentrating on stainless steel since the beginning of his career, has grown up with it from its infancy, and has in this way gained a thorough knowledge of its many modern applications. This knowledge is partially expressed in "Corrosion and Heat Resisting Steels."

BECOMING interested in nitriding and nitriding alloys when they were first introduced into this country, Dr. V. O. Homerberg has pursued this branch of metallurgy until he is now recognized as an authority on those subjects. In recognition of his mastery of the field he has recently been appointed technical director of the Nitralloy Corporation which controls the American assignment of the German patents.

Dr. Homerberg first studied pharmacy and science in Philadelphia, then entered Massachusetts Institute of Technology and received his degree of S.B. in chemical engineering in 1921 and Sc.D. in metallurgy in 1927. Starting as assistant in analytical chemistry in 1918 he rose until now he is associate professor of physical metallurgy.

He has acted as consultant for a number of manufacturing companies. In addition, he has published several articles on metallurgical subjects and is co-author of the textbook "Principles of Metallography." He is a member of the British Iron & Steel Institute, British Institute of Metals, American Institute of Mining & Metallurgical Engineers, and the American Society for Steel Treating.

ARTHUR H. BURNS is the engineer in charge of production for the New York Herald Tribune of New York City. He is a graduate of the Lawrence Scientific School of Harvard University. After leaving school he spent five years in mining in Idaho and California but changed to the building construction field in 1912. He has been resident engineer on several industrial projects and was the supervising engineer on the building for the newspaper which is described in his article.

Since 1923 he has been in charge of production for this newspaper and has directed the large additions of building and machinery which have been made to the plant since that date. He is also a member of the committee on mechanical affairs of the American Newspaper Publishers Association.

PROFESSOR GEO. B. HAVEN, the author of the article, on Textile Research at the Institute has long been identified with this class of work. The Textile Laboratory was originated by Professor Haven at the time of the World War, and was widely used by the Government in regard to acceptances, rejections, standardization and the general qualifications of fabric for peculiar uses. Professor Haven made the first analysis and complete investigation of the fabric, new at that time, for covering airplane wings. This was of pure cotton, thoroughly mercerized and carefully woven. In connection with this investigation, the Institute conducted twelve intensive sessions of "Ground Schools for Aeronautical Officers of the U. S. Navy and Army." A thorough study was made of mechanical fabrics in these schools. Professor Haven has been the author of many papers describing textile research apparatus and investigations. He is a member of the American Society for Testing Materials, U. S. Institute for Textile Research and the American Society of Mechanical Engineers.

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